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# AIR FORCE ⊕

# HUMAN RESOURCES

TEAM TRAINING FOR COMMAND AND CONTROL SYSTEMS:
STATUS

By

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Team training for command and control (C²) personnel (excluding air crews) in Tactical Air Command was surveyed. The methods used to define, develop, implement, and evaluate these team training programs were described, analyzed, and evaluated. The description was based on survey data collected through interviews with C² training personnel and observations of training in Tactical Air Command (TAC) and Air Training Command (ATC). The systems surveyed were Airborne Warning and Control System (AWACS), the Semi-Automated Ground Environment (SAGE), and Tactical Air Control System (TACS). The organizations surveyed in TACS were the Tactical Air Control Center (TACC) and Control and Reporting Center (CRC). Basic and automatic positional qualified

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training were also surveyed. Four additional technical papers have been published to document the $AFT^2C^2$ program: AFHRL-TP-82-8, AFHRL-TP-82-9, AFHRL-TP-82-10, and AFHRL-TP-82-11.

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# PREFACE

Throughout the text of this paper, reference is made to volumes I through V. These volumes have been published as separate technical papers identified as follows:

**Volume I**

Baum, D.R., Modrick, J.A., & Hollingsworth, S.R. *Team training for command and control systems: Status.* AFHRL-TP-82-7. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, April 1982.

**Volume II**

Modrick, J.A., Baum, D.R., & Hollingsworth, S.R. *Team training for command and control systems: Recommendations for research program.* AFHRL-TP-82-8. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, April 1982.

**Volume III**

Baum, D.R., Modrick, J.A., & Hollingsworth, S.R. *Team training for command and control systems: Recommendations for application of current technology.* AFHRL-TP-82-9. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, April 1982.

**Volume IV**

Hollingsworth, S.R., Modrick, J.A., & Baum, D.R. *Team training for command and control systems: Recommendations for simulation facility.* AFHRL-TP-82-10. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, April 1982.

**Volume V**

Baum, D.R., Modrick, J.A., & Hollingsworth, S.R. *Team training for command and control systems: Executive summary.* AFHRL-TP-82-11. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, April 1982.

This paper is the first of five volumes prepared by Honeywell to document the results of a research program to evaluate the current status of team training ($T^2$) for operators of complex Air Force command and control ($AFC^2$) systems, and to make recommendations for enhancing the $AFC^2T^2$ process. The research was performed for the Air Force Human Resources Laboratory under contract F33615-79-C-0025.

This paper contains the objectives and approach of the study, the results of a survey to assess the status of team training for command and control in Tactical Air Command, and a discussion of issues and problem areas which can be addressed by developing solutions within currently available technology and those that require more long-term research to develop solutions.

This research effort supports a major new Air Force Human Resources Laboratory research and development program whose primary objective is to improve $T^2$ technologies in areas particularly relevant to Air Force combat readiness. The program objective requires the establishment of a baseline data base on how $T^2$ is currently conducted in the Air Force: how it is developed, implemented, and evaluated. Because Air Force teams vary greatly in size, structure, and functions, it would be impractical to collect data on the training provided to all of them. Rather, the scope of this research effort had to be directed at an area with potential high payoff for increased combat readiness and effectiveness. The area of command and control was chosen as a point of departure for the research because $C^2$ teams tend to be well-defined structurally, are of a manageable size, and perform functions highly representative of Air Force mission needs. Furthermore, as the research effort unfolded, limited time and resources made it necessary to focus on tactical and air defense $C^2$ systems to the exclusion of strategic $C^2$ systems. Thus, the $C^2$ systems surveyed are, or in the case of planned systems will become, Tactical Air Command (TAC) resources.

The goal of this effort was to develop a picture, through interview and observation, of how AFC²T² is currently developed, implemented, and evaluated, and what C² training needs will arise in the future. Based on this picture, capabilities, limitations, and weaknesses of AFC²T² were identified and recommendations were developed in three areas:

- T² research and development program (Volume II)

- Resolution of issues using current techniques/technologies (Volume III)

- Simulation technology development for C²T² (Volume V)

These recommendations will form the foundation for future research by AFHRL into the performance of C² teams and systems. The research will encompass training technology, performance measurement techniques for C² teams and systems, human resources issues in the design and operation of C² systems, and training of command/decision skills. The ultimate goal of this program is to improve technologies in areas of team and human factors related to the combat effectiveness of Air Force C² operations.

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| | |
|---|---|
| AAR | After-action report |
| ADCOM | Air Defense Command |
| ADWC/IWS | Air Defense Weapons Center/Interceptor Weapons School |
| $AFC^2$ | Air Force command and control |
| $AFC^2T^2$ | Air Force command and control team training |
| AFOQT | Air Force Officers Qualifying Test |
| AFSC | Air Force Systems Command |
| APQ | Automatic positionally qualified |
| AQE | Airman Qualifying Exam |
| ART | Airborne radar technician |
| ARTEP | Army Training and Evaluation Program |
| ASO | Air surveillance officer |
| ATC | Air training command |
| AWC | Air Weapons Controller |
| $C^2T^2$ | Command and control team training |
| CDMO | Computer display maintenance technician |
| CRC/CRP | Control and reporting center/post |
| CT | Communications technician |
| CTS | Course training standards |
| ECM/ECCM | Electronic countermeasures/electronic counter-countermeasures |
| ESD | Electronics Systems Division |
| EW | Electronic warfare |
| IPS | Interceptor pilot simulator |
| ISD | Instructional system development |
| MAC | Military Airlift Command |

# LIST OF ACRONYMS (concluded)

| | |
|---|---|
| MAUT | Multi-attribute utility theory |
| MCC | Mission Crew Commander |
| NCS/JCS | National Security Council/Joint Chiefs of Staff |
| NWGS | Naval War Gaming System |
| OJT | On-the-job training |
| OTD | Office of Training Development |
| PMP | Program management plan |
| POI | Plan of instruction |
| RO | Radio operator |
| SAC | Strategic Air Command |
| SD | Senior Director |
| SDC | Situation display console |
| SID | Situation information display |
| SME | Subject matter expert |
| SPO | System program office |
| STP | System training plan |
| $T^2$ | Team training |
| TAC | Tactical air command |
| TACDEW | Tactical Advanced Combat Direction and Electronic Warfare |
| TADL | Tactical data link |
| TAFIIS | Tactical Air Force Integrated Information System |
| TCTS | Tactical Control Training Squadron |
| TRA | Training requirements analysis |
| WWMCCS | World-Wide Military Command and Control System |

# CHAPTER I

## INTRODUCTION

This report 1) discusses the background, scope, rationale, and approach of the effort; 2) reports the results of a survey of $AFC^2T^2$ programs, and 3) identifies $T^2$ issues and problem areas in need of resolution to improve $T^2$ technology for operators of $AFC^2$ systems.

This study supports a major new Air Force Human Resources Laboratory research and development program whose primary objective is to improve $T^2$ technologies in areas particularly relevant to Air Force combat readiness. The program objective requires the establishment of a baseline data base on how $T^2$ is currently conducted in the Air Force; how it is developed, implemented, and evaluated. Because Air Force teams vary greatly in size, structure, and functions, it would be impractical to collect data on the training provided to all of them. Rather, the scope of this research effort had to be directed at an area with potential high payoff for increased combat readiness and effectiveness. The area of command and control was chosen as a point of departure for the research because $C^2$ teams tend to be well-defined structurally, are of a manageable size, and perform functions highly representative of Air Force mission needs. Furthermore, as the research effort unfolded, limited time and resources made it necessary to focus on tactical and air defense $C^2$ systems to the exclusion of strategic $C^2$ systems. Thus, the $C^2$ systems surveyed are, or in the case of planned systems will become, Tactical Air Command (TAC) resources.

# PROGRAM OBJECTIVE AND RESEARCH SCOPE

This study was conducted with the goal of developing a picture through interview and observation of how $T^2$ is currently developed, implemented, and evaluated in the Air Force, and what $C^2$ training needs will arise in the future. Based on this picture, capabilities and limitations of current Air Force $T^2$ were identified. Issues and problem areas that need resolution to improve $AFC^2T^2$ are summarized and recommendations were developed in three areas:

- $T^2$ research and development program to address problems not within the current state of the art

- Resolution of issues using current techniques/technologies

- Simulation technology development for $C^2T^2$

These areas are expanded in the other reports.

The recommendations made as a result of this effort will form the foundation for future AFHRL research in $AFC^2T^2$ including the performance of both teams and systems in $C^2$. The ultimate goal of the program is to improve technologies in areas of team and human factors related to the combat effectiveness of Air Force ground operations. The scope will encompass training, performance measures and techniques for systems and teams, human resources in $C^2$ design and operation, and training of command/decision skills.

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## RESEARCH RATIONALE AND APPROACH

In order to conduct a meaningful research effort, it was necessary at the outset to restrict the number of $C^2$ systems to be surveyed. The area of $C^2$ in the Air Force is extremely complex and large. The rationale and events that impacted the research focus are discussed in this section.

Some of the problems which one must face in performing an exhaustive or even comprehensive survey of tactical air $C^2T^2$ can be illustrated by considering the network depicted in Figure 1. (see Table 1 for a key to acronyms). The figure represents the supporting Joint Force Operations of TAC. Each organization consists of personnel and equipment forming functional teams.

An in-depth survey of each organizational team is not feasible. In addition, the problem of a comprehensive survey is magnified further by the existence of other organizational networks of $C^2$ systems in TAC, $C^2$ networks in other commands such as Strategic Air Command (SAC) and Military Airlift Command (MAC), and national level $C^2$ such as the World-Wide Military Command and Control System (WWMCCS) and the National Security Council/Joint Chiefs of Staff (NSC/JCS).

The $C^2$ systems considered for inclusion in this survey are presented in Table 2. Each system is described in Appendix A to this volume. The systems considered fall into three categories: current, improvements to current, and planned or future.

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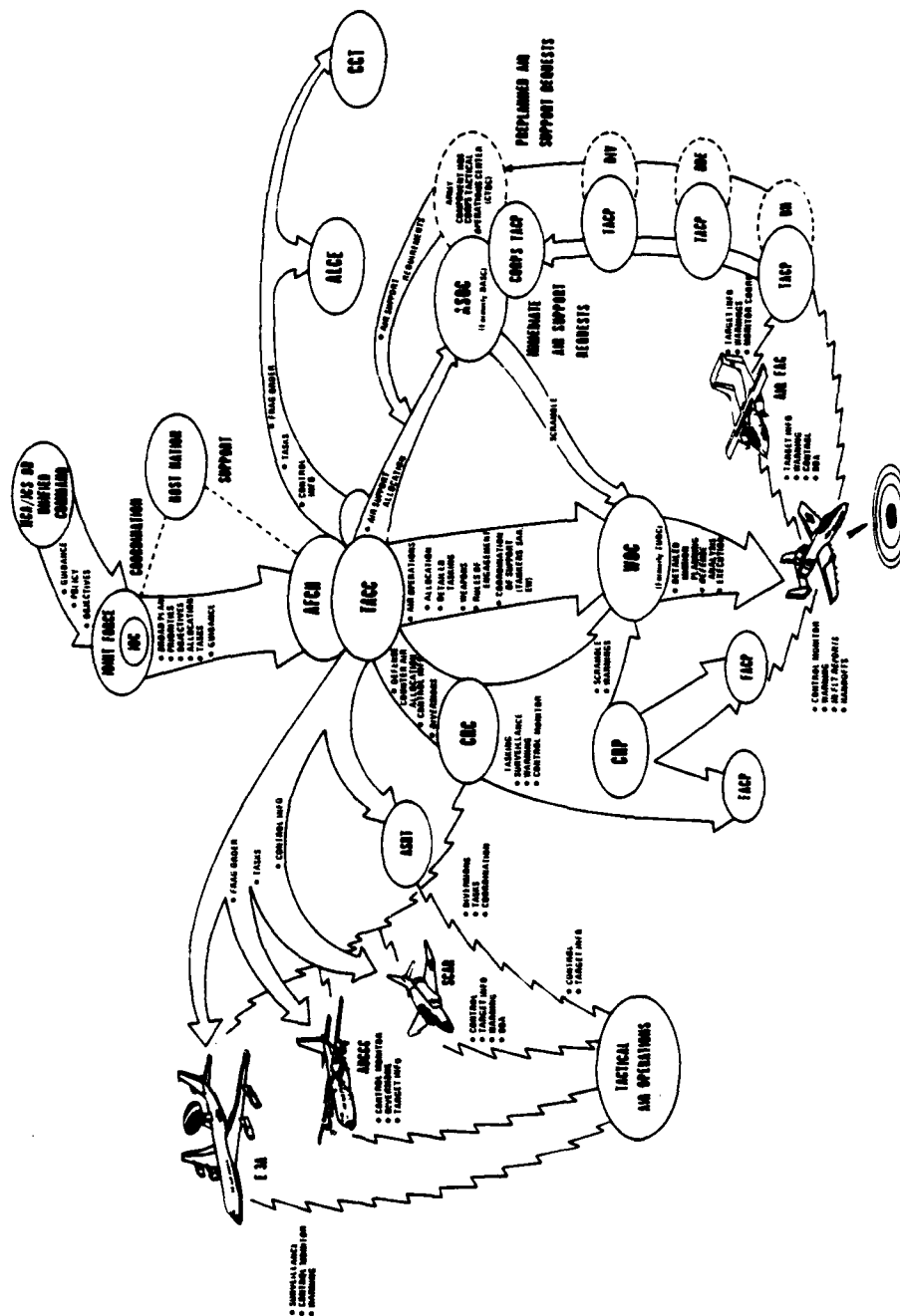
Figure 1. Tactical Air Force Supporting Joint Force Operations

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## TABLE 1. KEY TO ACRONYMS IN FIGURE 1

ABCCC    Airborne Command and Control Center

AFCH    Air Force Component Headquarters

ALCC    Airlift Command and Control

ALCE    Airlift Control Element

ASOC    Air Support Operations Center (formerly DASC-- Direct Air Support Center)

ASRT    Air Support Radar Team

BDE    Brigade

BN    Battalion

CCT    Combat Control Teams

CRC    Control and Reporting Center

CRP    Control and Reporting Post

DIV    Division

FAC    Forward Air Controller

FACP    Forward Air Control Post

JCS    Joint Chiefs of Staff

JOC    Joint Operations Command

NCA    National Command Authority

SCAR    Strike Control and Armed Reconnaissance

TACC    Tactical Air Control Center

TACP    Tactical Air Control Party

WOC    Wing Operations Center (formerly TUOC--Tactical Unit Operations Center)

TABLE 2. REPRESENTATIVE AIR FORCE COMMAND AND CONTROL SYSTEMS

| Current | Improvements | Planned |
|---|---|---|
| E-3A Airborne Warning and Control System (AWACS) | E-3A Airborne Warning and Control System Modifications (AWACS MODS) | Joint Tactical Information Distribution System (JTIDS) |
| Tactical Air Control Center/ Tactical Air Control System (TACC/TACS) | Tactical Air Control System Improvements--485L (TACSI) | Tactical Information Processing Interpretive System (TIPI) |
| Tactical Fusion Center (TFC) | Tactical Fusion Center/Combat Operations Information Center (TFC/COIC) | Battlefield Exploitation and Target Acquisition (BETA) |
| Airborne Command Post (ABNCP) | Advanced Airborne Command Post (AABNCP) | 2394 Operational Application of Special Intelligence Systems (OASIS) |
| Airborne Launch Control Center/ Airborne Launch Control System (ALCC/ALCS) | Airborne Launch Control System Upgrade (ALCS Upgrade) | Space Defense Operations Center (SPADOC) |
| Ballistic Missile Early Warning System Tactical Operations Room Upgrade (BMEWS TOR Upgrade) | Ballistic Missile Early Warning System Tactical Operations Room Modification (BMEWS TOR MODS) | Joint Tactical Communications (TRI-TAC) |
| North American Air Defense Command (NORAD) | North American Air Defense Combat Command--Combat Operations Center (NORAD COC) | 9681I Joint Surveillance System (JSS) |
| Semi-Automated Ground Environment Back Up Interceptor Center (SAGE/BUIC) | Strategic Air Command Automated Total Information Network (SATIN IV) | |
| Tactical Air Command Combat Information Center (TAC CIC) | | |
| Traffic Control and Landing System (TRACALS) | | |
| Strategic Air Command and Control System (SACCS) | | |
| Missile Launch | | |

Several sources were consulted in order to develop this set of $C^2$ systems, including a project listing for the Electronic Systems Division (ESD) of the Air Force Systems Command (AFSC), a number of government reports and articles in defense community magazines, the Tactical Air Force Integrated Information System (TAFIIS) Master Plan, and conversations with $C^2$ experts.

The number of systems considered had to be reduced to make this research effort manageable and compatible with the time and resources available. Command and control systems which promised high payoff in the form of significant $T^2$ issues were identified and then the sample was narrowed by selecting representative systems.

The first decision concerned the identification of $C^2$ systems which would yield high-payoff $T^2$ issues. The performance requirements for strategic and tactical $C^2$ systems and teams are different owing to differences along three situational dimensions. As summarized in Table 3, strategic $C^2$ is characterized by specifiable environmental conditions, predictable system states, and available solutions and probable consequences. On the other hand, tactical $C^2$ is characterized by unspecifiable conditions, unpredictable system states, and less available options and probable consequences. This suggests that strategic and tactical $C^2$ teams are different in structure and performance requirements and thus have different training needs. The informal data regarding strategic $C^2$ collected during this effort suggest that this is an accurate statement. The more established nature of the strategic situation, when compared to the emergent or unexpected nature of the tactical situation, indicates that tactical $T^2$ would be more difficult to train. Training must produce

TABLE 3. CHARACTERISTICS OF STRATEGIC AND TACTICAL $C^2$

|  | Strategic | Tactical |
|---|---|---|
| Environmental Conditions | Specifiable | Not specifiable |
| States of the System | Predictable | Not predictable |
| Probable Consequences (Solutions) | Available | Potentially available |

some skills that are generalizeable to a large set of possible conditions, states, options, and consequences. The difficulty entails producing those skills in such a way that combat readiness can confidently be assumed.

Improvements in $T^2$ can be expected to have a higher payoff in tactical $C^2$ systems owing to this emergent nature of tactical situations and the emphasis on real-time decision making. Therefore, it was proposed to concentrate on tactical $C^2$ systems.

The decision to focus on tactical systems excluded not only strategic systems including Missile Launch and SPADOC but also systems and programs that are primarily higher organizations for analysis and integration. These systems and programs include BETA and OASIS. NORAD COC itself was dropped because it would be unproductively redundant of information gathered on SAGE, which was surveyed as a representative part of the North American Air Defense System.

Ultimately, four current tactical/air defense $C^2$ systems formed the basis for the survey. They were SAGE, AWACS, TSQ-91 Control and Reporting Center (CRC), and TACC. The last two are part of the Tactical Air Control System (TACS).

These systems are representative of the tactical/air defense $C^2$ family and functions. The SAGE is nearing the end of its life cycle, the TSQ-91 is mature, and the AWACS is newly developed. The SAGE mission requires daily performance of tasks and procedures, while the TSQ-91 is only deployed in actual combat. The AWACS participates in actual combat and also plays a role in other operations (such as rescue), but not on a daily basis. The TACC system is largely manual in operation; computer support is only beginning to be introduced.

Finally, in order to ensure that recommendations could be made which anticipate future $C^2$ systems training requirements, five systems and subsystems in the developmental stage of acquisition were selected to be surveyed. They were the JSS--the replacement for SAGE, the TIPI, the TRI-TAC, the JTIDS, and the System Training Exercise Module (STEM)--an improved simulation capability for the TSQ-91. In addition, technological developments which will provide advanced system capabilities in the 1990s were surveyed.

Information was also gathered on Red Flag and Blue Flag, two large-scale exercises run periodically each year. The purpose of the exercises is to provide experience and training for teams in tactical air warfare. A Red Flag exercise was observed. Blue Flag was not observed as a result of schedule conflicts and availability of resources to do adequate observations.

However, the facility at Eglin AFB was visited and the exercise was discussed with some individuals associated with management of Blue Flag.

The primary purpose of Red Flag is to exercise fighter pilots in air defense against a Red force fighter threat. Live flights are used for both sides and the aggressor force uses Red tactics. Ground-based intercept controllers participate for both Blue and Red forces. AWACS participates in some exercises as a Blue asset. Observation of an AWACS mission was the purpose of our visit. Unfortunately, AWACS did not fly because of a mechanical failure. Observations were made then of the intercept controllers and management of the exercise.

The purpose of Blue Flag is to provide experience and training for personnel of a Tactical Air Control Center of the Tactical Air Control Systems. It is oriented toward staff training in battle management. A numbered Air Force is the primary player; there are no radars and no live flying. The TACC is fully manned and exercised, but no lower-level components of TACS are. Their functions on the effects of the activities are simulated. The operation of the simulation is largely manual; the TACC itself is primarily manual and has a large manual plotting board rather than consoles with CRTs and keyboards.

The sites visited during the survey are presented in Table 4. The data collection methods used in the survey are discussed in Appendix B to this volume.

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## TABLE 4.  SITES VISITED AND RATIONALE

| Base/Location | Reason |
|---|---|
| Luke/Phoenix, Arizona | TSQ-91 Weapons Controller training |
| Tyndall/Panama City, Florida | Weapons Controller basic technical training; manual and automatic systems |
| Keesler/Biloxi, Mississippi | Weapons Technician basic technical training; individual training plans and development |
| Tinker/Oklahoma City, Oklahoma | AWACS $T^2$ |
| Nellis/Las Vegas, Nevada | Red Flag to observe AWACS participation |
| Duluth/Duluth, Minnesota | SAGE $T^2$ |
| Langley/Norfolk, Virginia | HQ TAC $C^2T^2$ planning |
| Eglin/Pensacola, Florida | TSQ-91 $T^2$ and TACS test bed |
| Shaw/Sumter, South Carolina | TACC $T^2$ |
| Hanscom/Bedford, Massachusetts | ESD $C^2$ system design and acquisition |

The remainder of this volume contains a brief review of relevant literature and technical documentation, results of interview of training program personnel, and a summary of observations of training.

## DEFINITIONS AND FRAMEWORK FOR ANALYSIS

There is a need to establish a common ground by defining how the terms command and control, and team training, will be used in this report.  Also

the term Instructional System Development (ISD) will be defined because it was used as a framework for discussing definition, development, implementation, and evaluation of $AFC^2T^2$ programs. Finally, a preliminary model for considering $AFC^2T^2$ is presented as an organizing element for the remainder of this report.

## Command and Control and $C^2$ Systems

The DoD Dictionary of Military and Associated Terms (JCOS Pub 1) defines $C^2$ as:

> The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of his mission. $C^2$ functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures which are employed by a commander in planning, directing, coordinating, and controlling forces and operations of his mission.

Many variations of nomenclature exist such as $C^3$ and $C^3I$ for referring to $C^2$ but the additional functions are redundant with the above definition. Therefore, $C^2$ is used in this report to encompass all these terms.

Generally, a system is an arrangement of things which are related to form a unity. In a military context, the things in the arrangement may be personnel, equipment, units, etc, or a combination of these. Air Force $C^2$ systems are complex, organized entities composed of many such elements. For example, Figure 1 depicts the Air Force system which supports joint force operations. (The acronyms in the figure are

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decoded in Table 1.) Each center, post, unit, or aircraft depicted in Figure 1 is itself a system, or more properly, a subsystem of the tactical operations structure. Each subsystem consists of personnel equipment organized to allow certain $C^2$ functions and tasks to be carried out.

Take, for example, the Control and Report Center (CRC) of the Tactical Air Control System (TACS). A typical CRC consists of approximately 90 people, a hardware/software system known as the TSQ-91 (407L), and other equipment. The CRC is organized into roughly four functional areas: surveillance, identification (both acquisition and information), command/ battle staff (decision making), and weapons control (implementation). This type of $C^2$ team structure is illustrated in Figure 2. Each of these functions is performed by a number of personnel organized in a section which is supported by equipment or information. The essential components of a TSQ-91 are consoles which display radar imagery and the personnel who observe it to determine the location, heading, and speed of aircraft and missiles.

The CRC thus functions to a large degree in a real-time $C^2$ mode. Individuals performing the functions noted above in the CRC and other tactical air $C^2$ systems make complex decisions under high stress. This report is about the performance required of such individuals, especially in a team context as defined below, and how those individuals and teams are trained.

```
                        ┌─────────────────┐
                        │   BATTLE STAFF  │
                        └────────┬────────┘
          ┌──────────────┬───────┴───────┬──────────────┐
   ┌──────┴──────┐ ┌─────┴──────┐ ┌──────┴──────┐ ┌─────┴──────┐
   │   WEAPONS   │ │    AIR     │ │MOVEMENTS AND│ │ AIR TRAFFIC│
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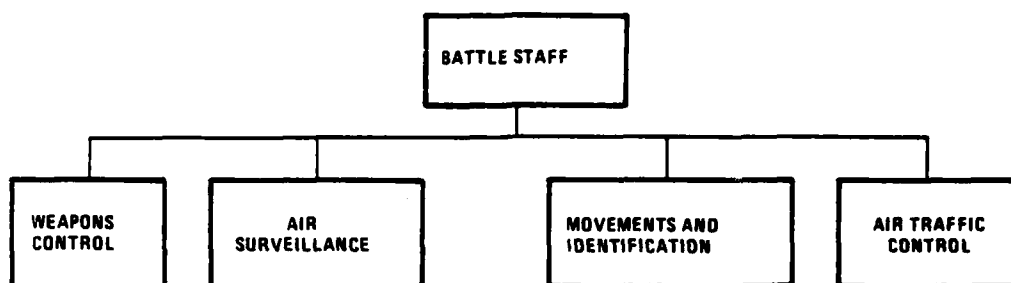
Figure 2.   Generic Structure of Air Force Tactical or Air
            Defense Command and Control System

## Teams:  Performance and Training

A team is a collection of individuals engaging in cooperative activities to
achieve a common goal.   Teams may be partly distinguished from other
goal-oriented groups because teams are "usually well organized, highly
structured, and have relatively formal operating procedures" while other
small groups are "rarely so formal with such well defined, specialized
tasks" (Reference 1).   While the distinction between teams and small
groups may be made on the basis of formal structure and procedure, it
is important not to overlook performance.   Several teams with the same
structure and procedures may greatly differ in the achievement of
mission goals and objectives.   By structure and procedure they are

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equivalent teams; in practice they are not. $C^2$ teams operate in a complex, stressful environment in which performance is a function of interaction among multiple factors and components. The processes by which the more productive teams function are more adaptable and robust. Therefore an adequate definition of a team must include both structural and process parameters.

Meister (Reference 2) includes an element of performance in his description of team characteristics. He identifies three primary characteristics of teams:

- Relatively rigid structures with formal organization and communication networks

- Well-defined positions or member assignments

- Cooperation or coordinated participation of several specialized individuals whose activities contain little overlap

In general, any man-machine system containing two or more operators working in interaction involves a team. Moreover team performance is often described as a unitary phenomenon. That is, the team, rather than the individuals, works to a mission requirement, performs tasks, receives feedback, and adjusts its behavior to changing demands (Reference 2).

Research on the team is usually based on the assumption that there is some element of team performance which is somehow different from the collective performance of a set of independent individuals. Analytic

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research suggests that the interaction between team members is the critical element of team performance. The simplicity and generality of this suggestion makes it both appealing as an explanation and difficult to prove or disprove. The types of team training which it suggests (for example, communication, coordination) are necessary but probably not sufficient to achieve a high level of team performance.

Team Performance/Training Model--Team training cannot be adequately discussed without a consideration of team structure as the context for performance. A complete discussion must also include an analysis of the specific military training which prepares personnel for team positions.

Brock (Reference 3) has proposed a model which incorporates team context and performance with levels of training. The model breaks the team into units which are meaningful in both performance and training, and shows where the particular team is directly related to other elements in the system. The model has proved to be a useful analytic tool in application (Reference 4).

Four levels of performance, context, and training are established: individual, subteam, team, and superteam. The levels of training are illustrated in Figure 3 for the position of weapons controller in a CRC/CRP. Positional duties and interface functions with other positions are learned during individual training. Combinations of individuals are brought together during the subteam level to develop crews within functional areas such as weapons direction, surveillance, battle staff, and other areas. The team training level is devoted to integrating these crews within an organization

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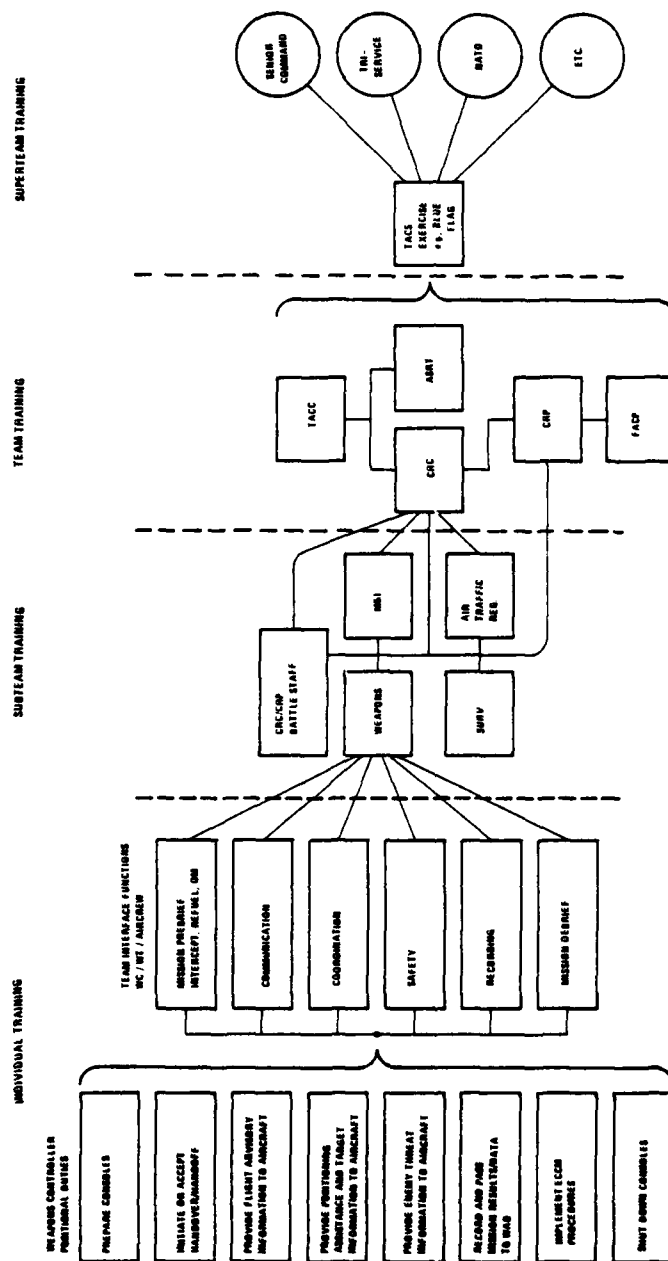
Figure 3. Team Training for CRC/CRP Weapons Controller

into a team capable of accomplishing the mission of the organization such as a TACC, CRC/CRP, ASRT, and FACP. Finally, the superteam level consists of multi-organizational/multi-team exercises which involve more than one organization within a command, from two or more commands and multi-service.

This model is not necessarily how training is actually done or defined in any organization; rather, it is a statement of the conditions for adequate training to occur based on observation and analysis of teams and training.

A further description of the team performance/training model will be presented and an example from Air Force command and control will be developed further. The example is running an intercept. The team running the intercept consists of the pilot and the ground personnel doing surveillance and weapons direction.

Individual Performance and Training--Performance at the individual level is focused on the individual operator and behavior is described for the uniquely individual task elements. Each member of a team has a set of individual skills which must be performed if the team is to successfully operate as an integrated unit. An aircraft pilot, for example, must have a large set of complex skills in order to fly today's advanced aircraft.

Training at the individual level should be more inclusive than just how to perform a task. The pilot should have information not only on how to perform the individual task elements and practice at doing so, but also should have information on where those task elements fit into the larger team context.

<u>Subteam Performance and Training</u>--Performance at this level is focused on subsets of the larger team, for which proficiency in recurring interactions is a necessary component of effective team performance. Training at this level should consist of the development of unique subteam performance skills. The full set of individual skills for the particular position and knowledge about the subteam are requisite to this level.

It is usually possible to identify several subteams within a team. During an intercept it is necessary for the weapons controller and the pilot to interact on a recurring basis so that the aircraft is maneuvered close enough to the hostile to pick it up on the pilot's airborne radar. Both the pilot and the weapons controller must have a "feel" for the hostile's tactics, the characteristics of the aircraft, and the tactical situation so that they may select an intercept course, anticipating events and leading the target appropriately.

<u>Team Performance and Training</u>--Performance at the team level is focused on the immediate set of individuals tasked with a common goal. They are the primary team. They may or may not share a common location, but they are always linked somehow. In an intercept one might consider the pilot, weapons controller, and weapons controller technician to be the relevant team.

The team has a set of objectives and an overriding goal. These objectives and goals are usually stated at the team level. Team performance is described only when it is evaluated against these objectives and goals. However, performance is most easily observed at the individual and subteam levels.

Training at this level should involve the development and practice of
unique team performance skills. Usually this means the integration of
individual and subteam skills in a real or realistic environment.

Superteam Performance and Training--Performance is focused at the
team level but now includes interaction with those friendlies who direct
or are directed by the team. This interaction may establish goals, be
directed to achieving specific objectives, or request or provide information.
In an intercept one might consider the superteam to consist of the pilot,
weapons controller, and weapons controller technician (the immediate
team), together with surveillance personnel and the weapons assignment
officer. Surveillance initially picks up the aircraft and identifies it as
friendly or hostile. If hostile, the weapons assignment officer is informed
and a weapons controller is assigned to handle the intercept.

Training at this level should involve the further integration of the team
into the framework in which it will function during actual combat.
Referring to Figure 1, the CRC, for example, would exercise in support
of a TACC and simulate communications with it and, perhaps, the AWACS,
a CRP, or FACP. If the TACC were the unit in question, then superteam
elements would include AFCH, ALCC, CRC, AWACS, ASOC, WOC, and
so on (see Table 1 for acronym meanings).

This integration of individual and team skills in a real or realistic
environment depends upon the prior development of individual, subteam,
and team skills, together with knowledge about the larger framework
within which the team will perform.

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This discussion shows how the structure and performance of a group of persons with a common set of goals and objectives is conceptually broken down into individual, subteam, team, and superteam components. Training can be designed to achieve specific performance objectives within each of these components.

The process of dividing the group into those components is not well defined. The boundaries drawn during analysis are somewhat arbitrary and depend on such factors as the purpose and time scale. Moreover, a set of criteria do not exist which allow the observer to decide whether the divisions are appropriate. However, the model's flexibility and ease of use make it a useful analytic tool despite its several shortcomings.

## Extension of the Team Training Model/Performance

Two dimensions of personnel category and training program type will now be added to the four levels of team performance context. Figure 4 shows these dimensions and the categories within each of them. The following discussion on personnel is based on an air defense mission such as that found in a TACS. Similarly, the types of training programs are based on the practices and regulations in TAC.

Personnel Category--There are three personnel categories in $C^2$ systems: console operators and support personnel, first-line supervisors, and battle staff.
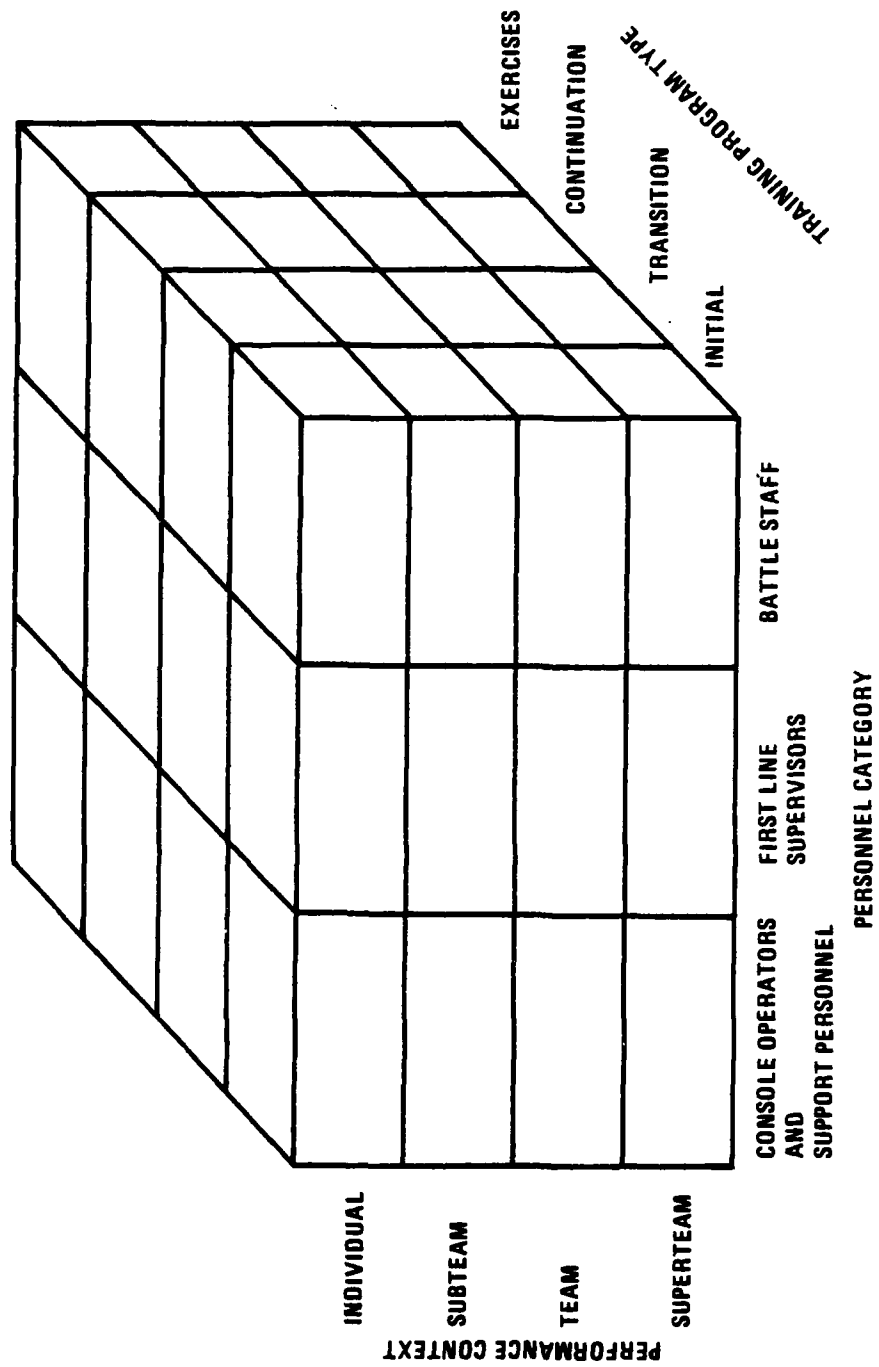
Figure 4. Preliminary Model of $AFC^2T^2$

Console operators and support personnel include weapons controllers/
directors; weapons technicians; surveillance, tracking, and height
technicians; plotters, tellers, and recorders; and airborne radar
technicians, radio operators, and computer maintainers and operators.
These individuals perform functions which involve the control of individual
aircraft or the development of information and data which reveal  the
state of the battle.

First-line supervisors consist of weapons directors, senior controllers,
surveillance officers, radar inputs countermeasures officers, and height
and tracking noncommissioned officers.  These individuals manage people
and air resources under their immediate control.

Finally, there are the personnel of the battle staff, consisting of the
commander and his assistants in planning, operations, logistics,
intelligence, and so on.  These individuals manage information and
resources.

Training Program Type--Air Force training is accomplished in both
institutional and operational settings.  As a general rule, institutional
training is the responsibility of Air Training Command and operations
training is the responsibility of the operational command; Tactical Air
Command in this case.  Institutional training is formal and involves
courses with a specific curriculum and length.  Operations training is
typically informal and training is on-the-job.  There may also be some
formal classroom instruction and there are self-study programs.

Air Force training consists further of a progression through four levels designed to 1) impart initial fundamental knowledge and skills in a particular career field and specialty; 2) transition those knowledges and skills to an operational environment; 3) provide for continuation (upgrade, advance, or maintenance) of knowledges and skills; and 4) exercise those knowledges and skills under conditions which attempt to simulate actual job conditions as closely as possible (Reference 5). The survey indicated that an institutional setting was characteristic of initial training, the first phase of transition training and certain advanced training within the continuation category. All other training, including most $T^2$, is conducted in an operational setting.

The need for initial training of console operator and support personnel is well accepted. Table 5 is a list of courses which exist for these purposes. The performance context in these programs is primarily individual but subteam contexts such as controller-technician-pilot are also fundamental to this training.

The first phase of transition training of console operators and support personnel has been formalized into an institutional format for the three $C^2$ systems surveyed. The training responsibility shifts from Air Training Command to TAC. In the case of SAGE this training occurs in the units. Both the CRC and AWACS have training squadrons whose sole mission is to prepare console operators for the transition from classroom to an operations setting. The 607th Tactical Control Training Squadron (TCTS) accomplishes this for the TACS CRC and the 966th AWACS Training Squadron for AWACS. The primary performance contexts of this type of training are individual and subteam; team contexts are used by some, but not all, personnel.

TABLE 5. AFC$^2$ INITIAL TRAINING

| Course | Length | Location | Organization | Purpose |
|---|---|---|---|---|
| Air Weapons Controller Fundamentals | 6 weeks | Tyndall AFB | 3625th TTS (ATC) | Weapons control skills, manual system |
| Air Weapons Controller Fundamentals Manual Systems | 7 weeks | Tyndall AFB | 3225th TTS (ATC) | Weapons control skills, manual system |
| Automated Positionally Qualified (APQ) Air Weapons Controller | 10 weeks | Tyndall AFB | ADWC/IWS (TAC) | Weapons control in auto-mated systems |
| Weapons Controller (ECCM Operations) | Unknown | Keesler AFB | 3390 TTG (ATC) | Air surveillance/RICMO |
| Aircraft Warning and Control System, Operator (Manual) | 3 weeks | Keesler AFB | 3390 TTG (ATC) | Teller, plotter, recorder, technician |
| Aircraft Warning and Control Systems Operator (Manual/SAGE) | 6 weeks | Keesler AFB | 3390 TTG (ATC) | Teller, plotter, recorder, technician, SAGE/BUIC |
| Aircraft Warning and Control System, Operator (Manual/TACS) | 6 weeks | Keesler AFB | 3390 TTG (ATC) | Teller, plotter, recorder, technician, TACS |

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Training in operations settings is informal. In general, first-line supervisors and battle staff are trained in team and superteam contexts primarily in exercise programs. The exercises vary in scale and may be local or involve other units. Blue Flag is an example of a large-scale exercise for the TACS TACC.

## Instructional System Development (ISD)

Instructional System Development is an attempt to provide and standardize a systematic method for developing and managing training programs. Team training can be incorporated more readily into the existing procedures if its analysis and development are at least compatible with ISD. At any rate, ISD provides a preliminary framework.

Training programs have a life cycle consisting of three stages: definition and development, implementation, and evaluation. These three stages can be systematically and effectively carried out through the application of ISD, which details the steps and analytic techniques to be followed and applied.

The use of ISD is required by regulation. However, there are differences among the armed services on the ISD model and procedures. Each service has developed its own model and procedures. There is also an interservice model developed jointly by the Army and Navy known as ITRO (Reference 6). The Air Force prescribes the use of ISD "to plan, develop, and manage" all training and educational programs whether new or modified (AF Regulation 50-8). Regulation 50-8 (Reference 7) specifies the use of AFM 50-2 (Reference 8), AFP 50-58 (Reference 9), or ITRO for accomplishing ISD.

There are several drawbacks and inadequacies in existing ISD methods.
There is no guarantee, for example, that the application of two different
ISD models to the same training problem will result in identical programs
because the procedures differ slightly or are more or less well-specified
from any one model to another. Also, the same model applied by two
different institutions or groups may not yield identical programs.
These points illustrate that although the ISD technique is well-formulated,
it is largely heuristic in its application. Therefore, the particular ISD
model used and the institution or group developing instruction are factors
bearing on the effectiveness of the definition and development process.
In order to avoid such problems, we need to adopt a standard which, if
not algorithmic, is at least complete in specifying all necessary steps
to be performed.

Vineberg and Joyner (Reference 10) have developed a generalized model
of the ISD process. Based on an analysis of the service models and
ITRO, their ISD model specifies a set of 19 steps. Table 6 presents
their model and shows how the steps may be segregated into four phases:
assessment of training need, analysis of training requirements, transition
from requirements to implementation, and program evaluation. These
phases of the ISD process parallel the organization of the subsequent
chapters of this volume in which the status of $AFC^2T^2$ is characterized.

The purpose in adopting an ISD framework was to provide a set of rubrics
for planning the analysis of training programs, data gathering, reporting
results, and discussing them. There are problems and deficiencies with
ISD procedures but these are largely at levels below which ISD is being
used in this study. Some of the problems have been discussed. Another

## TABLE 6. STEPS OF A GENERALIZED ISD MODEL
### (After Vineberg and Joyner, 1980--Reference 10)

| | |
|---|---|
| ● Assessment of training | Needs |
| ● Identification of job requirements | |
| ● Selection of tasks for training | Training |
| | Requirements |
| ● Analysis of tasks | Analysis |
| ● Construction of job performance measures | |
| ● Selection of setting | |
| ● Development of training objectives | |
| ● Development of achievement tests | |
| ● Identification of entry knowledge/skill levels | |
| ● Classification of objectives and selection of instructional activities | |
| ● Selection of instructional methods | |
| | Transition from |
| ● Selection of media | Requirements to |
| | Specific Program |
| ● Grouping and sequencing of instruction | |
| ● Development of plan for authoring and managing instruction | |
| ● Review and selection of existing materials | |
| ● Authoring of instruction | |
| ● Validation of instruction | |
| ● Internal evaluation | Program |
| ● External evaluation | Evaluation |

significant problem is that the procedures are not satisfactory for describing cognitive or semi-structured tasks in emergent situations; they work best for fixed procedural tasks in established situations. The population of tasks of teams is heavily weighted with cognitive semi-structured tasks. Furthermore, ISD does not provide procedures for deriving features of simulation. However, the intended use of ISD in this study does not include doing detailed task descriptions or analysis. Its use is intended to provide a framework which is consistent with existing practices in the training community.

## The Role of ISD in Team Training Tactical Air Command

A first approximation to a generalization about the role of ISD is that it is used in some form for formal, institutional training courses but is not used for developing informal, operational training and exercises. ISD is used to define training requirements and objectives by analysis of job performance requirements, to prepare training materials, and to evaluate the training program.

The courses for initial training listed in Table 5 were developed in this manner. Some courses which antedate ISD were restructured and ISD-justified once the method was adopted. The TAC courses for transition training into SAGE, CRC, and AWACS were also developed by ISD.

In contrast, informal and on-the-job training (OJT) in operational settings has little formal structure. It emerges out of the events and problems that occur in exercises. The exercises vary in scope over single units,

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multiple units, and the complexity of Blue Flag exercises and JCS exercises such as Gallant Eagle, Brave Shield, and Bold Eagle.

Training needs and training objectives do not appear to get explicit consideration. Console operators and support personnel might be able to get credit for some STAN/EVAL requirements but these requirements are usually met during supervised exercises within the squadron. First-line supervisors and battle staff members appear to be trained entirely during exercises at the scale of team and superteam levels.

The design and development of exercises, whatever their scale, do not follow anything approximating an ISD procedure. Training requirements and objectives are rarely defined. Feedback is informal and unsystematic. After-action reports (AARs) are written, endorsed, and filed. We found no procedure to ensure their use in planning subsequent exercises or to ensure that they be used in a formal and systematic manner.

The procedure for preparing exercises which was described by our respondents is based on a committee of representatives from the participating units and consultants. The participating units might be a CRC/CRP, TACC, and Wing headquarters. The consultants are exercise developers under a support contract. The committee discusses what it can and would like to do and reaches a consensus. The consultants then prepare the scenario, tapes of simulated imagery, and scripts.

The ostensible purpose of the exercise is often something other than training. One exercise that we observed was held for the purpose of evaluating a communication switch under development. The organizations involved were two CRPs, a CRC, and a TACC. We observed in the CRC during the first day. Squadron personnel observed performance of individuals, took notes, and debriefed the unit. We observed in the TACC during the second day and were present for the planning teleconference of all participants at the beginning of the second day. The main business of the teleconference was changes in the exercise to get a better test of the communication switch. There was no discussion of training needs or objectives.

Red Flag is explicitly a training exercise for fighter pilots. Planning for an exercise begins 45 days prior to its scheduled date. Training needs of the pilots are given more consideration, perhaps in part because the exercise is run by pilots to serve the needs of pilots. Still the exercise is planned by committee and the procedure is informal, unsystematic and non-ISD. Training for ground controllers and AWACS personnel in Red Flag, however, is a relatively unstructured, serendipitous byproduct.

OVERVIEW OF THE PRESENTATION OF SURVEY RESULTS

The status of $AFC^2T^2$ is characterized in the succeeding chapters of this volume. Chapter II describes, analyzes, and evaluates the definition and development of $AFC^2T^2$. Similarly, Chapter III deals with $AFC^2T^2$ implementation and management, and Chapter IV with program evaluation and modification. Within each chapter the topic of simulation is given

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co-equal status with training program issues. Simulation is a key element of $C^2T^2$ because all training is carried out under simulated conditions as compared to actual combat. Even training that involves live flying is conducted under conditions of simulated combat condition. ISD does not treat simulation beyond its potential selection as an appropriate training medium. This is a weakness of ISD as applied to $AFC^2T^2$. Chapter V of this volume summarizes the strengths and weaknesses of $AFC^2T^2$ and identifies issues and problem areas in need of resolution.

## SUMMARY OF STRENGTHS AND WEAKNESSES OF $AFC^2T^2$

The results of the interviews and observations are summarized into two sets of generalizations stating the strengths and weaknesses of $AFC^2T^2$. They are organized into the categories of definition and development, implementation and management, and evaluation and modification, representing the major phases of the life cycle of a training program.

The analyses during the study deal predominantly with the weaknesses since a purpose of the study was to recommend research and development projects that will contribute to improving $AFC^2T^2$. The weaknesses were condensed into a set of underlying issues and problem areas which will be discussed soon. The recommendations were derived from the issues and problem areas.

Strengths

Definition and Development--

- $C^2$ system design documents, for example, data items, provide ample opportunity for incorporating good human factors.

- $AFC^2T^2$ personnel are dedicated and motivated and perform admirably considering the limited resources they have.

- Recognition of the critical importance of $C^2T^2$ for joint service operations is increasing.

- Systematic procedures within Instructional System Development (ISD) exist for identifying individual operator job tasks and task elements, especially as related to the equipment console.

- The importance of simulation in accomplishing $C^2T^2$ is well-accepted.

- The development of course control documents, for example, course training standards, curriculum lesson plans, etc., provides formal training objectives for individual operator initial and advanced training.

- The System Training Plan developed for new systems is a comprehensive instructional management and production plan.

Implementation and Management--

- Individual operator skills are systematically trained; difficulty is sequenced effectively.

- The limited, predictable nature of static air defense missions makes their training relatively straightforward; system training exercises for SAGE are well-defined.

- The standardization/evaluation program is clearly successful in monitoring individual skills readiness.

- Intrateam briefings addressing issues of intra- and inter-section performance are helpful in building team awareness and a shared plan.

Evaluation and Modification--

- The independent (from a specific training program) status of the Tactical Air Control System Office of Training Development is necessary for meaningful program evaluation.

- The standardization/evaluation program prevents major discrepancies in $T^2$ programs.

- Questionnaire approaches are positive attempts to query students and operational units regarding the quality of training programs.

- Expert judgment is essential to the evaluation of $T^2$ programs, especially large-scale exercises like Blue Flag.

The strengths show good programs for individual training and the existence of the mechanisms and practices necessary for developing, conducting, and evaluating training. Throughout the survey it was evident that $AFC^2$ training personnel were concerned about improving the effectiveness of $T^2$. The picture emerged of competent, dedicated individuals doing the best they could with limited resources and technologies. There is a recognition of the weakness of $C^2T^2$ and a desire to take positive, corrective action.

Training for individual operators is effectively developed and implemented. The assessment of operators' individual skills is comprehensive and well-standardized. Efforts to build team identity and spirit through intrateam briefings are good.

Weaknesses

Definition and Development--

- Enforcement of human factors data requirements is incomplete or lax as a result of pressures to develop the system.

- Training is often incorrectly viewed as a panacea for ineffective system design.

- Joint services system acquisition, for example, TRI-TAC, put stress on training developers who might have to contend with different training philosophies and personnel constraints.

- In competition for scarce or limited resources, the $C^2T^2$ area has historically had a low priority in the Air Force.

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- There are no systematic procedures for defining the appropriate team structure for a $C^2$ system or for allocating tasks to the team as opposed to the individual operator or system software.

- Instructional System Development (ISD) techniques do not address team tasks, skills, or $T^2$ objectives, nor do they adequately address non-console tasks and the tasks of non-operators.

- There are no systematic procedures for defining $C^2$ system simulator requirements; nor is there empirical data on the level of fidelity required for $C^2 T^2$.

- The procurement of $C^2$ systems radically different from existing systems, for example, AWACS, puts pressure on training developers because "job" experts find it difficult to relate to unfamiliar operating procedures.

- The definition of $T^2$ requirements is hampered by a lack of articulation of what constitutes proficient $C^2$ team performance.

- Training requirements for operations training programs (in-unit) are of dubious validity because they have not been related empirically to $C^2$ skills achievement and maintenance.

- Operations training program requirements for live $T^2$ are constrained by the availability of flying resources.

- Training objectives are developed informally, if at all, for transition and continuation training in the context of simulated combat missions/system exercises.

- The selection of instructional methods, media, and sequencing is primarily influenced by factors unrelated to training effectiveness; namely, tradition, resource constraints, etc.

- Unified, comprehensive plans dealing with the management and production of operations training do not exist.

Implementation and Management--

- There are no minimum aptitude requirements for entry into the Air Weapons Controller career field.

- Team-oriented skills are not trained systematically; sequencing of training is not optimized.

- There is no formal, standardized training for $C^2$ system supervisors.

- The emergent nature of tactical missions makes tactical skill training difficult; simulated combat missions/system exercises for AWACS and TACS are ill-defined.

- The evaluation of team readiness is hampered by a lack of articulation of the dimensions and attributes of good team performance.

- Team readiness assessment is not standardized in terms of conditions and difficulty.

- The importance of feedback to teams is recognized but there are no proven techniques for making feedback effective.

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- Simulators do not fully support instructor requirements.

- Simulation fidelity does not support effective training.

- Personnel who simulate interceptor pilots are not formally trained for their duty.

- $C^2$ career fields are characterized by low retention rates and the steady loss of experienced individuals.

- $C^2$ training program managers have an incomplete understanding of the $C^2 T^2$ pipeline.

Evaluation and Modification--

- The successful use of an ISD analysis to evaluate a training program depends upon having unbiased subject matter experts; because instructors in the program usually provide the expertise there is inherent bias in the evaluation.

- The lack of objective, behavior-referenced criteria for assessing team-oriented skills and team performance limits the STAN/EVAL effort.

- Given the unvalidated relationship between operations training program requirements, in terms of, for example, number of intercepts a quarter, and skills maintenance, the achievement of those requirements should not be used as an evaluative measure.

- The measurement tools of the expert are unsophisticated, informal, undocumented, and depend on the experience of the particular expert involved.

- Incomplete documentation of ISD analyses complicates program modification and makes it inefficient.

- Training programs are occasionally modified as a result of resource shortages or changes in management philosophy; such modifications frequently reduce the quality of training.

- There are few resources for and very low priority is given to modifying simulators which are known or demonstrated to be deficient in fidelity or capability.

A salient weakness found during the survey was a lack of formal $T^2$ programs for $AFC^2$ systems. There are large-scale exercises for systems and joint operations. However, they have tended to become ends in themselves rather than being based on and targeted to the job requirements of an operational environment and training needs or objectives. Exercises are limited by inadequate simulation capabilities to support $T^2$ and the unavailability of live flying resources.

Current measurement techniques do not support evaluation of teams or team training programs. The lack of diagnostic measures of team operational readiness will hamper research and application efforts aimed at increasing it.

A critical problem, low retention of experienced individuals, exists in the $C^2$ career fields. The contributing factors mentioned by the survey respondents were in the areas of low job satisfaction and dissatisfaction with career opportunities. Great pressure is exerted on the training pipeline to provide proficient replacements. Given the importance of

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subject matter experts throughout the training cycle, the rapid turnover
and loss of experienced individuals threatens the foundations of effective
Air Force operations.

The low priority given to human factors and training in system acquisition
exacerbates the problems that already exist and causes others. Poor
system design can sometimes be overcome through training but this is
not desirable nor does it make effective use of training resources. A
limited number of actual equipment trainers are available and they have
limited capabilities to support training, especially in the areas of training
functions to support student and instructors. This deficiency is a result
of limited resources for training, unavailability of knowledge to address
$T^2$ requirements to procure simulators and training devices, and inadequate
provision for $T^2$ requirements in the design and procurement phases for
$C^2$ systems.

# CHAPTER II

# STATUS OF AFC$^2$T$^2$ PROGRAMS: DEFINITION AND DEVELOPMENT

## OVERVIEW AND GENERAL ISSUES

Training program definition and development involves the identification of knowledge and skills to be trained, determination of the level of proficiency to be achieved, and specification of how the training is to be accomplished and evaluated. A number of factors influence the overall efficiency and effectiveness of the entire definition and development process. General factors include C$^2$ system design, joint system acquisition, management philosophy, and fiscal constraints. These general factors are discussed in this section. Specific topics are discussed in the following sections. They consist of assessment of training needs, training requirements analysis, transition from requirements to the program, and simulator definition and development.

## C$^2$ System Design

Training is not a panacea for poor system design but it may have to overcome the effects of poor design to achieve adequate proficiency. The keyboard of the AWACS Situation Information Display (SID) console serves as a ready example.

An alphabetic keyboard is used to enter call signs and other test data.
The keys are sprung quite stiffly to avoid inadvertent entry; further, they
are arranged in an unconventional format:

```
A   E   I   M   Q   U   Y
B   F   J   N   R   V   Z
C   G   K   O   S   W
D   H   L   P   T   X
```

A set of special characters complements the keyboard.  Touch typing
is difficult and slow because of the spring tension and keyboard layout.
A frequent remark was that a typewriter keyboard layout would have been
more sensible from a training/human factors perspective.

There are ample opportunities during the acquisition cycle to incorporate
good human factors in system design.  Data item descriptions require
the development of plans, design approaches, and data bases to ensure
that, a system is easily usable by humans:  DI-H-7053 (Reference 11),
DI-H-7056 (Reference 12), and DI-H-3268A/Q-118-2 (Reference 13).
In fact, these data items are made part of the contractual obligation during
system acquisition.  But because system acquisition primarily means
the procurement of hardware, software, and their capabilities, the human
factor often waits at the end of the line when it comes to contract performance.
According to interview data, the reality is that even when the data items are
required, the enforcement of the requirements is incomplete or lax as a
result of pressures to develop the system itself.

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The reasons for this low priority of human factors are not clear and it is debatable whether they can be determined. The deliberations that result in short shrift for human factors occur at many points during budget allocation and system design. They are typically informal rather than the outcome of a systematic cost-benefit analysis. Further, they are unrecorded and thus not retrievable for analysis and evaluation.

Our respondents who commented on this issue usually attributed it to more importance being placed on hardware and number of systems. However, that reasoning is circular. The reasons must lie in characteristics of human factors and the acquisition process.

Some currently popular explanations include assertions that human factors are considered too late in system design; acquisition cost rather than life cycle cost is the principal criterion for acquisition. However, other contributing factors might be the lack of evidence or methodology to show during development that human factors can make a comparative, cost-effective contribution to system effectiveness and the absence of sufficient data to identify and support critical human factors decisions. These factors are especially true for the cognitive information processing semi-structured tasks which are common in $C^2$ teams.

The human factors specialist is seldom able to state quantitatively the impact of a system feature on individual or system performance or the loss from not incorporating a human factors feature. Comparatively, the engineering disciplines can state quantitatively what effects their recommendations will have on parameters such as range, speed, or fire power. Whatever the reason, training today must often compensate for

poor design features, inadequate man-machine interfaces, or deficiencies in system capability. This expectation is unreasonable and has the consequences of increased training costs and reduced proficiency. Of course, the exact cost and reduction involved are unknown.

## Joint System Acquisition

There are several $C^2$ systems in acquisition, for example, TRI-TAC and BETA, in which different branches of the military are procuring different components of the system. For example, the Army has overall responsibility for TRI-TAC, but the Air Force is procuring the Central Nodal Communications Element, one of the manned components of the system. The Army and Air Force have different technical career fields, training philosophies, and quality of personnel. The potential problems for the training developer--Air Training Command (ATC)--are enormous under these circumstances. Issues of compatibility of classifications for personnel and skill levels, minimum levels of proficiency, and compatibility of training objectives must be resolved before training can be developed.

## Management Philosophy and Fiscal Constraints

The combination of overall Air Force mission requirements and budget cuts or restraint puts a great strain on $AFC^2T^2$ training definition and development. Airplanes have the highest priority; in competition for scarce resources, they win out in all respects over $C^2$ systems. Furthermore, a general hardware orientation has a negative impact on training within $AFC^2$. This is true for systems acquisition and ongoing training.

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For example, if the available funds will buy an additional system capability or a training device, generally the system capability wins out; if there is a choice between training pilots and training weapons controllers, pilots are trained.

This is not intended as a criticism, although there are some circumstances in which decision criteria should be criticized. Rather, it is simply to *point out a fact of life regarding Air Force training*, especially in an operational setting. Training developers must do the best they can with limited resources and any recommendations for improving the quality of $AFC^2$ training must take this fact into account.

SPECIFIC FACTORS

In addition to these general or background factors, there are specific factors affecting the efficiency of four different activities of the training program definition and development process. These four activities are: 1) assessment of training needs, 2) training requirements analysis, 3) transition from requirements to the training program, and 4) simulator definition and development. In the following sections each of these activities is described in terms of the methods employed and their products. Strengths and weaknesses of the activities are discussed. When applicable, the steps of the generalized ISD model presented in Chapter I are used to organize the description of each activity.

## Assessment of Training Needs

Training program definition and development is initiated by specific needs. Training needs in $AFC^2$ arise from one of two circumstances: 1) system acquisition or modification, or 2) the achievement and maintenance of operational readiness. These two circumstances require different needs assessment techniques, as the following discussion will illustrate.

System Acquisition/Modification--The system acquisition process is formal and carefully regulated. An acquisition cycle begins with definition of a system concept, progresses through concept validation and engineering development, and ends with production and deployment. Thus an accompanying training program should be defined and developed simultaneously. However, this is rarely the case, especially for transition, continuation, and exercise programs. Training needs are identified during concept validation, more fully defined during engineering development, and finalized when a system goes into production.

The system acquisition process is guided by a Program Management Plan (PMP) which is developed by the staff of a newly organized System Program Office (SPO). Section 11 of the PMP, a living document that evolves as the system concept is fleshed out, deals with personnel and training. It is the ATC training manager's responsibility to ensure that as the program progresses the description of the training program and related topics becomes definitive. Further, the training manager is to develop a System Training Plan (STP) that details actions required to implement ATC-controlled training for a new system.

The initial step in assessing the training need during concept validation
is a system analysis. This is a joint undertaking by ATC, AFSC, TAC,
and system developer representatives. An important output of the system
analysis is the personnel requirements of the system. These requirements
provide the set of jobs which must be performed, and ultimately trained,
to operate and maintain the system.

It was not within the scope of this effort to determine the precise nature
of the methods used by experienced Air Force and industry personnel
to define system personnel requirements. However, there is no agreed-
upon method to define performance requirements in $C^2$ systems or team
training. Thus engineering methods influence training requirements
and determine the information available.

The effectiveness of any method in determining system personnel
requirements will vary with the nature of the system being analyzed.
The relevance of the new system to existing systems is a key factor
influencing the validity of the jobs identified. For example, the personnel
structure of JSS overlays that of the SAGE. Likewise, the jobs to be
performed within JSS are highly similar to those performed within SAGE.
Consequently, the establishment of a valid personnel structure is relatively
straightforward.

On the other hand, the establishment of the AWACS personnel structure
was difficult because of the smaller team size as compared to SAGE and
TSQ-91. This team size change altered the AWACS personnel job
descriptions compared to the similar positions in SAGE and TSQ-91
and altered the familiar team structure of $AFC^2$ systems.

Thus, the system designer and users could not readily draw on a body
of knowledge about function, skills, and training objectives. The
personnel subsystem has to evolve out of analysis of man-machine
functions, extrapolation of experience and trial and error. Simulation
and system analytic techniques may some day provide tools to design
and compare different concepts for personnel configuration. However,
they are not available now and probably would be too costly and time-
consuming if they were.

Regardless of the specific method through which the system personnel
structure is established, the identification of distinct jobs
initiates training development. The need for training console operators
and support personnel in an individual performance context is very well
accepted. Though the job positions are identified, the need for training
supervisors and battle staff is not formally established during system
acquisition.

The acquisition of computer-based $AFC^2$ systems establishes a need for
definition and development of simulation. Recognition of this need is based
on the requirements to create conditions under which system training
for developmental test and initial deployment can take place. The radar
display consoles which are integral to $AFC^2$ systems must be simulated
in order to provide the cues for operator performance. Live flying is
not a realistic possibility for accomplishing system training during
development and production. Consequently, computer programs which
simulate radar returns must be developed for use on the actual equipment.
The definition and development of simulation/simulator requirements is
discussed in the final section of this chapter.

Modification of a deployed system requires assessing training needs within the context of ongoing training programs. The assessment process during modification is decentralized as compared to system acquisition. This decentralization reduces the efficiency of the need assessment, but because training program modification is easier than definition and development, the impact is not great.

Achievement and Maintenance of Operational Readiness--The primary peacetime mission of $AFC^2$ organizations is training in order to achieve and maintain operational readiness. Under these circumstances, the primary responsibility for assessing the training need shifts from ATC to TAC personnel. The factors influencing the efficiency of the decision process shift also as a consequence of TAC's overall mission and management structure. The decision context is less formal; training needs are based on professional judgment of readiness to meet the threat. Individuals who perceive a training need must lobby with their colleagues and superiors to arrive at a consensus.

Over the years the need to have operational training programs consisting of transition, continuation, and system training has been firmly established in this manner.

Transition training meets the training needs of console operations and support personnel and this informal lobbying is effective in identifying training needs at this level. They are effective in capturing and using the knowledge of experienced personnel and the results of experience with training on the system. This approach should be examined to delineate

more clearly how it is done and how it works. Perhaps it can then be adopted for use in training requirements analysis for continuation and system training.

Informal lobbying and conferencing characterizes needs assessment and requirements analysis that lead to definition and development of large-scale system exercises like Blue and Red Flag and training courses taught at the Air Defense Weapons Center/Interceptor Weapons School (ADWC/IWS). They seem to work less well than they do in transition training. Most recently the perception of a lack of training for $C^2$ in joint service operations has made interoperability a key $AFC^2$ training need.

System programs and large-scale exercises are intended to address team and superteam training needs and provide a context for OJT of supervisors and battle staff. They need improvement which should start with the determination of training requirements.

At least once, the assessment of training need by TAC has resulted in the definition and development of a TAC initial training program, the Automatic Positionally Qualified (APQ) course originally developed in 1975. Initial training is for the most part the province of ATC rather than TAC. The course is an intermediate step between the ATC fundamental manual skill qualification course and initial transition training at the 607 TCTS or a SAGE division.

It is not clear why this course is taught by TAC. Certainly TAC established
the training need and had the equipment and facility available within
ADWC/IWS. However, ATC should have the course responsibility because
it is not oriented toward system-specific skills. The existence of this
situation is indicative of an incomplete Air Force policy regarding the
relationship between training need assessment on the one hand and program
definition and development on the other.

In summary, training development starts with the assessment of training
needs for specific jobs identified in a system. The assessment techniques
needed are different for new acquisition and maintenance of operational
readiness in existing systems. There are differences in the information
available, the personnel who must participate in the development, and the
agencies which are responsible for training development. However, existing
procedures for determining training needs are designed primarily for the
situations of new acquisitions and individual training managed by training
command. Training for achievement and maintenance of operational
readiness is the responsibility of the operational command; existing
procedures are inadequate for assessing training needs in that context.

TRAINING REQUIREMENTS ANALYSIS

Once a training need has been established, the training which must be
developed can be defined through a training requirements analysis (TRA).
Following the generalized ISD model, the steps in TRA involve 1) identifying
job requirements, 2) selecting tasks to be trained, 3) analyzing selected
tasks, and 4) constructing job performance measures. Each step has a
product associated with it. For example, job requirements are represented

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as a prioritized list of the job performance tasks. As there is no Air Force regulation that they be formally documented, the products of a TRA (excepting job performance measures) are rarely found unless a specific requirement existed at the time it was performed; for example, a system developer may be contractually obligated to perform a job task analysis and deliver the documented results to the government.

An exception to this situation was found at the 4444th Tactical Air Control System/Office of Training Development (TACS/OTD) at Luke AFB. The unit personnel have documented the TRAs produced for the TSQ-91 Air Weapons Controller and Air Surveillance Officer/Technician. These products are indicative of the efficiency and dedication with which the TRAs were undertaken. They provide a basis for describing and evaluating the TRA techniques that are employed to define requirements for first-phase transition training for TSQ-91 console operators and support personnel. Because ISD methods are used to define training requirements for other initial and advanced training programs, this description and evaluation should apply to those methods in a general way, except where the survey discovered evidence to the contrary.

Definition of $AFC^2$ operations training requirements in TAC is the responsibility of HQ TAC/DOAO for AWACS and DOCTO for TACS. These requirements take the form of minimum numbers of events or hours per topic or activity. They are not the result of a formal TRA. Expert professional judgment serves as the basis for determining the requirements; for example, in establishing the mix between live and simulated flying. In the case of live events or activities, the requirements are constrained by the number of live sorties of different aircraft types

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that are projected for a certain period of time, for example, a month.
Thus, the training developed to promote achievement and maintenance
of operational skills is not defined according to documented methods and is
not based solely upon training requirements. Both of these facts are
characteristic weaknesses of operations training programs.

The situation described above also characterizes large-scale exercise
programs. At best, the training requirements established are constrained
by resource considerations; at worst, there is no analytic requirements
definition.

In summary, formal TRAs are applied only to individual jobs and skills in
initial training programs. Guidelines do not exist for defining individual
and team training requirements for operations and large-scale exercise
training. This definition rests on professional judgment and is heavily
influenced by non-training factors.

The following discussion of the four ISD steps in TRA describes the methods
employed and the factors bearing on the effectiveness of the methods.
The steps are identification of job requirements, selection of training
requirements, analysis of tasks, and construction of job performance
measures.

Identification of Job Requirements

This step has been called the "keystone of the ISD process" (Reference 10).
The purpose of this step is to produce a valid list of job tasks prioritized
in terms of frequency, difficulty, criticality, and the like. These tasks are

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then used as the basis for all subsequent requirements analyses. The
adequacy of the procedures for this step for describing jobs of teams in
command and cost role is critical.

Existing procedures are established by the requirements of DI-H-6130
(Reference 14), Tasks and Skill Analysis Report. Job tasks are defined
as part of system development for acquisition of new systems. Depending
upon the relevance of the new system to existing systems, there may be
task lists available from existing occupational surveys or the Military
Task Data Bank. Even if these data are not specifically available, the job
requirements for new system operation are usually related to existing
specialties. Typically, the system developed can depend upon resident
military job experts to identify job requirements. The resulting list of
job tasks is documented as part of a Task and Skill Analysis Report
(DI-H-6130), a data item which the government requires on most system
development/production contracts.

DI-H-6130 includes only general guidelines for identifying job requirements.
Further, the scope is limited to equipment operators. Failure to adequately
address unique jobs or tasks, non-console tasks, and tasks of non-operators
results. Many $AFC^2T^2$ jobs consists of these types of tasks. In addition,
DI-H-6130 does not provide task priorities. It needs to be augumented to
meet the needs of $C^2T^2$.

When a new system departs significantly in technology or operation from existing systems, unique jobs or job tasks may be created. If this occurs, job experts either do not exist or they are hampered in identifying tasks because of unknown or incomplete operating procedures. In such situations the training requirements will be incomplete at best and invalid at worst.

Summarizing the deficiencies of DI-H-6130 applied to new systems, it does not include guidance regarding different possible types of tasks and their relation to mission objectives, although the identification of job tasks is required to be related to the total mission. Individual tasks and tasks requiring team efforts are not distinguished from one another. Consequently, training requirements for team skills are not explicitly defined. The tasks of non-operators, for example, certain support personnel, supervisors, and battle staff, are not specifically identified. If training is to be developed for these personnel, then the burden of TRA falls on ATC. Finally, in DI-H-6130, there is no requirement to provide task priorities in terms of frequency, criticality, or difficulty. These data have an impact on selection of tasks for training.

One consequence of the first and third shortcomings noted above is clearly evident in AWACS training. Although the Senior Director (SD) and Mission Crew Commander (MCC) have jobs involving some console operation, no job task lists have been developed because these are supervisory positions. So, despite the fact that the SD and MCC job include some operator tasks, there is no formal training of them.

Where initial and advanced training is defined and developed by TAC, expert judgment is again employed to derive task lists. The job requirements are more clearly related to operational mission requirements. Take, for example, the task listing produced by TACS/OTD for the TSQ-91 Weapons Controller. It is very general, as shown in Table 7. The eight tasks are basic to the job of a weapons controller. Five of the eight tasks (2 through 6) imply interaction with other team members, and thus they may be considered the forerunner of team training requirements. The remaining three tasks refer to equipment operating procedures. The task priority data consist of an index of the importance (impact) of correct task performance and the task learning difficulty. This information is potentially important in making tradeoffs in training program development.

In developing the list of tasks for Weapons Controller performance, the general conditions of a combat theater are used. If garrison conditions are used, some lesser tasks would have to be added. On the other hand, several very significant tasks would have to be eliminated. Table 7 presents a general listing of tasks performed by the CRC/CRP positional Weapons Controller. Included with the listing is a rank ordering from one to three, an indication of the importance of correct task performance, and the learning difficulty of the task performance.

In summary, the guidelines for identifying job requirements during system acquisition are incomplete. They do not relate well to the purpose of the TRA and provide no guidance for distinguishing between individual and team tasks. Application of the ISD guidelines for identifying job requirements produces task lists consistent with the goals of the TRA. However, here, too, there is no explicit recognition of team skills.

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## TABLE 7. TSQ-91 WEAPONS CONTROLLER TASK

| Number | Task | Impact | Learning Difficulty |
|--------|------|--------|---------------------|
| Task 1 | Prepares radar and radio console to provide control services to aircraft. | 1 | Easy |
| Task 2 | Initiate or accept handover/ handoff of aircraft. | 3 | Easy |
| Task 3 | Provides flight advisory information (as necessary or requested) to aircraft en route to/from mission area. | 2 | Moderate |
| Task 4 | Provides positioning assistance and target/rendezvous/objective briefing to aircraft for specific aircraft mission requirements. | 1 | Difficult |
| Task 5 | Provides enemy threat information to aircraft in mission area (the area of Aerial Combat Tactics). | 1 | Moderate (Complex) |
| Task 6 | Records and passes mission results/data to other agencies. | 3 | Easy |
| Task 7 | Implements radar console and communications ECCM procedures. | 2 | Easy (Complex) |
| Task 8 | Shuts down radar and radio consoles. | 3 | Easy |

Provides control services to aircraft in a declared emergency situation.

Originally identified as Task 8, however, determined is only a change in "condition" while task performance remains same as in Tasks 2, 3, and 4.

## Selection of Tasks for Training

According to ISD, some tasks should be selected and others rejected for training based upon the priorities of the task list, training resources, and cost. The survey produced no evidence of selectivity of tasks per se. Rather, all the tasks identified as job requirements are trained to one degree or another, or under some conditions and not others, with no apparent rationale. It is possible that this is an artifact of the listing process in that only those tasks to be trained are listed. Level of task proficiency to be achieved and conditions of task performance are determined later in the definition and development process.

For system and large-scale exercises, the system tasks which are trained are determined by the particular resources available. For example, if an AWACS is available for a live TACS exercise, then the tasks associated with TACS-AWACS coordination will be trained. If an AWACS is not available, no training in such tasks occurs. The number of live intercept exercises is determined by the number of fighter aircraft scheduled to fly rather than the training needs of personnel in surveillance and weapons control.

## Analysis of Tasks

The purpose of task analysis is to determine under what conditions a task must be performed and what standards of performance are required to do the job. Task analysis results in a detailed description of tasks and task steps, and associated environmental and equipment conditions and behavioral criteria of performance.

Task analysis is a difficult, time-consuming procedure which must be carried out by skilled professionals. Both behavioral and subject matter expertise must be available. During system development a great deal of imagination is necessary to describe tasks that will be performed on equipment that does not yet exist under conditions that are not completely specifiable. Because production time may be short or the required expertise unavailable, as when the system contractor must meet a demanding schedule within cost, the results of task analysis are rarely complete, detailed descriptions of job tasks and performance conditions or criteria.

The instructions for preparation of the Task and Skill Analysis Report are very clear regarding what information to include. However, there are two additional factors which influence the quality of the report. First, there are few guidelines on the methods to be used in obtaining the information. Second, task analysis is a low-priority, low-budget activity relative to the overall system development/production process.

These factors result in inconsistent methods being applied by individuals who vary in level of expertise and knowledge. A high degree of imagination and creativity is needed to describe job steps in the absence of a physical system. Time and budget constraints work against this need. Finally, the amount of effort which is put into task analysis will be the minimum necessary to satisfy the letter, not the intent, of the data item requirement.

The task analysis obtained from the 4444th TACS/OTD does not contain all of the information required by either ITRO or the Air Force ISD model (see Table 8). For example, performance conditions are described only briefly and the performance standards are not specified. Included for each task element are the type of performance required (discrimination, recall, problem-solving, manipulation, or speech) and the learning difficulty (easy, moderate, difficult, or very difficult). These data are useful for making decisions related to training development, but are not directly related to a TRA.

The tasks described in the TACS/OTD analysis include the individual and team-oriented steps and elements required to do the job. A statement of training requirements is derived by comparing this description against an assessment of entry-level skills (a separate ISD step discussed under transition from requirements to program). The training requirements (see Table 9) are presented in such a general way that the specificity of the task analysis is lost. Consequently, in the analysis there is no definitive statement of the individual- or team-oriented skills to be trained. This state of affairs is a function of the format and method chosen for the analysis rather than a result of factors related to the nature of the tasks or the training program.

## Construction of Job Performance Measures

Interviews and observations did not reveal the methods used in constructing job performance measures. The end result of the process is a standard form consisting of factors to be evaluated and instructions regarding the scoring technique.

## TABLE 8. TAC/OTD WEAPONS CONTROLLER TASK ANALYSIS

Task 3: Provides flight advisory information (as necessary or requested) to aircraft en route to/from mission area (for example, weather, traffic advisories, friendly artillery).

| Step Number | Steps in Performing the Task | Principal Type of Performance | Learning Difficulty |
|---|---|---|---|
| 3.1 | Recognize when to provide the various types of information. | Discrimination | Moderate |
| 3.2 | Recognize specific information that should be provided. | Discrimination | Moderate |
| 3.3 | Locate information. | Recall | Easy |
| 3.4 | Read information. | Manipulation/recall | Moderate |
| 3.5 | Report that information to aircraft in appropriate format and sequence. | Recall/speech | Moderate |

Skills and Knowledge--Task 3: Know radio R/T. Read weather display. Read artillery display. Operate radio subset. Operate telephone subset. Discriminate friendly radar tracks that pose "stranger threat" to each other.

## TABLE 8. TAC/OTD WEAPONS CONTROLLER TASK ANALYSIS (concluded)

Task 4: Provide positioning assistance and target/rendezvous briefing to aircrew for specific aircraft mission requirements.

| Step Number | Steps in Performing the Task | Principal Type of Performance | Learning Difficulty |
|---|---|---|---|
| 4a | (Subtask) Select/confirm tactic and technique to be employed. | ---------- | -------- |
| 4a.1 | Note relative location of aircraft and the designated target/rendezvous/objective. | Discrimination | Easy |
| 4a.2 | Determine control aircraft capabilities and mission requirements. | Discrimination/recall | Very difficult |
| 4a.3 | Determine target/rendezvous/objective parameters or capabilities (movement, formation, etc). | Discrimination/recall | Very difficult |
| 4a.4 | Evaluate "conditions" for mission impact. | Discrimination | Difficult |
| 4a.5 | Recall alternative tactics and techniques. | Recall | Difficult |
| 4a.6 | Select appropriate tactic and technique to be employed. | Problem solving/discrimination | Very difficult |

Skills and Knowledge--Task 4(a): Read Offensive Mission Display. Know basic capabilities of primary friendly tactical aircraft (speeds, arms, manuverability). Know basic capabilities of expected enemy aircraft (speeds, arms, manuverability). Read frag data. Read track ARO.

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## TABLE 9. TSQ-91 WEAPONS CONTROLLER TRAINING REQUIREMENTS

**Task 3: Provide Flight Advisory Information**--Student was required in ATC course to provide "stranger threat" information and weather information. Training requires proficiency practice in those, plus any new in the TACS (for example, friendly artillery warnings, to include reading the display boards).

**Task 4: Provide Positioning Assistance and Target Briefing--**
Subtasks

    a. Select/confirm tactics
    b. Provide guidance positioning
    c. Brief aircrew on target parameters
    d. Coordinate with other agencies
    e. Release aircraft to mission final control agency

In the ATC school, student is required to demonstrate guidance positioning on airborne target interception and on air refueling rendezvous. It is likely the tactic (or approach to target) was specified in advance. Also was required to brief aircrew using "standard" R/T.

Training requirement must allow student to acquire ability to select the best approach to target (tactic) for any situation, both air-to-air and air-to-surface missions. (Positioning after tactic selection is a matter of gaining proficiency on-scope and learning rules of thumb.)

Associated with tactics selection is knowledge training in specific aircraft capabilities, aircrew tactics and mission objectives, and flight safety considerations that are pertinent to radar control efforts. For the most part, the student is only familiar with the subtasks, other than select tactic, and proficiency is expected to be very low. Emphasis will be on training activities that allow skill proficiency. Since tactical engagement parameters for interception, etc, are short-range, there should be no need for proficiency (that is, training) with the CPU-73 Attack Computer. Rather, knowledge proficiency training should be oriented to the rules of thumb in solving the air mass problem, with reference to the attack computer only as an additional resource. Since manual skills form the basis of AWC abilities, manual skill proficiency should be emphasized with the HM4118 computer utilization skills as additive.

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The factors to be evaluated are directly related to job tasks. Because different positions may involve the same or closely-related tasks, one form can apply to several positions. For example, Air Defense Command (ADCOM) Form 745, presented in Table 10, covers evaluation of Senior Directors/Technicians and Senior Weapons Directors/Technicians for SAGE, GYK-19, and manual systems.

Scoring is defined in terms of an ordinal rating scale. The scale may have two (satisfactory/unsatisfactory) or more categories. Several categories are described in terms of the level of proficiency or knowledge which must be demonstrated in order for the performance to receive the associated score. For example, on a 0 to 5 scale, 0 indicates no knowledge of the task, 3 indicates an ability to do or knowledge of most parts of the task, and 5 indicates knowledge of or ability to do the complete task quickly and accurately, and ability to tell or show others how to do the task.

The job measures used throughout the $C^2$ systems surveyed are of this general type. The specific standards of performance for each task or evaluation factor are not explicitly stated on the form. These standards, if they are documented, are described in positional handbooks which are discussed in the next section. Often the standards are not documented, but rather are established by the level of proficiency or knowledge of the most experienced job experts. This makes the construction of job performance measures extremely difficult for new systems and has a negative impact on training implementation and evaluation.

## TABLE 10.   ADCOM FORM 745

| SENIOR DIRECTOR/TECHNICIAN (SD/T) AND<br>SENIOR WEAPONS DIRECTOR/TECHNICIAN (SWD/T) EVALUATION FACTORS<br>(SAGE/GYK-19/Manual Systems) | DATE CONDUCTED |
|---|---|

| NAME OF INDIVIDUAL EVALUATED (Last, first, middle initial) | GRADE | ORGANIZATION |
|---|---|---|

| PURPOSE OF EVALUATION | SYSTEM (Check applicable box)<br>☐ SAGE  ☐ GYK-19  ☐ MANUAL |
|---|---|

### INSTRUCTIONS

This form is designed to provide guidance for the evaluation of the position specified above.  Each item will be scored 0 through 5.

      0 - Demonstrated no knowledge of the task.

      1 - Demonstrated some knowledge of the task.  Needs to be shown or told how to do the task.

      2 - Demonstrated ability to do or knowledge of simple parts of the task.

      3 - Demonstrated ability to do or knowledge of most parts of the task.

      4 - Demonstrated ability to do or knowledge of all parts of the task.  Meets standards for speed and accuracy.

      5 - Demonstrated knowledge of or ability to do the complete task quickly and accurately.  Can tell or show others how to do the task.

A score of 5 WILL be attained on any item preceded with a ■.

Any score below 4 WILL be explained on reverse of form, prefixed with the appropriate item number.  Weak or recommended improvement areas WILL be noted on reverse of form, also prefixed with the appropriate item number.

| KNOWLEDGE OF OR PROFICIENCY IN<br>EVALUATION FACTORS | SCORE | Continuation | SCORE |
|---|---|---|---|
| 1. MISSION PLANNING (Include mission briefing) | | SUBTOTAL BROUGHT FORWARD | |
| 2. LRR/AEW&C OPERATIONS AND RADAR CAPABILITIES | | ■ 14. ARTCC PROCEDURES, MAJOR AIRWAYS, AND RESTRICTED AREAS (ESCAT/SCATANA) | |
| ■ 3. LEVELS OF OPERATION AND TRANSITION PROCEDURES | | 15. WEAPONS CAPABILITIES (Interceptor and ADA) | |
| ■ 4. COMPUTER PROGRAM/STARTOVER/SWITCHOVER PROCEDURES | | 16. INITIAL STOP MANNING AND FIGHTER FLOW | |
| 5. RADIO AND TOOL CAPABILITIES AND PROCEDURES | | ■ 17. WEAPONS EMPLOYMENT/RULES OF ENGAGEMENT/TRACK ASSIGNMENT | |
| ■ 6. INTERCEPTOR SQUADRONS, BASES, AND TARGET COMPLEXES | | 18. MONITORING WEAPONS AVAILABILITY AND WEATHER CONDITIONS | |
| 7. ADA AREAS AND PROCEDURES | | 19. LOCAL POLICIES AND PROCEDURES | |
| ■ 8. PLC PROCEDURES/ALERT NOTIFICATION AND FORMAT DISSEMINATION PROCEDURES | | 20. CONSOLE UTILIZATION AND KNOWLEDGE OF DISPLAYS | |
| ■ 9. NUCLEAR POLICIES, MNBA, AND WEAPONS CONTROL CASES | | 21. USE OF AVAILABLE AIDS (Checklists, status boards, etc.) | |
| 10. EMERGENCY ACTIONS AND REPORTING PROCEDURES | | ■ 22. INTERNAL AND EXTERNAL COORDINATION INCLUDING HANDLING OF INTELLIGENCE INFO | |
| 11. TACTICAL ACTION REPORTING PROCEDURES | | ■ 23. SUPERVISION AND KNOWLEDGE OF SUBORDINATE SECTIONS | |
| 12. NO-NOTICE EXERCISE PROCEDURES | | 24. PTC PROGRAM AND PROCEDURES | |
| ■ 13. UNKNOWN TRACK PROCEDURES | | 25. R/T AND COMMUNICATIONS DISCIPLINE | |
| SUBTOTAL | | TOTAL | |

| TYPED OR PRINTED NAME AND GRADE OF EXAMINER | SIGNATURE | | ORGANIZATION | PERCENTAGE |
|---|---|---|---|---|

**ADCOM** FORM JAN 75 **745**   PREVIOUS EDITION IS OBSOLETE.

The survey did not discover any analytic or other methods being used to construct team or system performance measures. No documented measures of team readiness exist. The only existing measure of team or system effectiveness is percentage of targets detected and intercepted during a live or simulated exercise. The characteristics of this measurement technique are described in Chapter III.

Thus, there is a lack of explicitly specified methods for developing performance measures, scores, and empirical, demonstrated relationship between performance measures and the readiness of a team or unit. The consequence of these tasks is uncertainty concerning the validity and utility of the performance measures for indicating proficiency and training needs, if they have any validity at all. These conditions also foster practices of measuring what can be measured readily in order to satisfy a bookkeeping requirement, rather than developing measures to gather information on what ought to be known to evaluate performance and training adequately.

TRANSITION FROM TRAINING REQUIREMENTS TO TRAINING PROGRAM

The generalized ISD model described earlier includes 12 steps to be carried out in the transition from training requirements to training program. In order to more closely approximate the manner in which this transition is accomplished in the Air Force, these 12 steps are collapsed into six, as follows:

- Select setting and type of training

- Develop training objectives

- Determine and develop proficiency assessment techniques

- Select instructional methods, media, and sequencing

- Develop plan for program management and materials
  production

- Produce/validate instruction

In the Air Force these six steps (and thus this portion of the ISD process)
are accomplished with reference to regulations specifying how and when
certain training-related documents must be prepared. These documents
include course training standards (CTSs) required by Air Force Regulation
8-13, and curriculum documentation such as course charts, plans of
instruction (POIs--equivalent to syllabi developed by TAC), and lesson
plans required by ATC Regulation 52-6. During system acquisition, CTSs
and course charts become part of a system training plan (STP) used by ATC
to guide instructional development. POIs, syllabi, lesson plans, and
other necessary training material are produced in accordance with the STP.

These documents provide a ready means for recording decisions made
during the training program development process. In fact, to a large
degree, the ISD requirement in the Air Force is met by producing these
documents (Reference 10). This may be more a function of the unit or
organization carrying out the ISD process, as evidenced by documentation
of training requirements analyses found at the 4444th TACS/OTD.

In the following discussion of the six development steps, the purpose and contents of the various documents are described in conjunction with the pertinent step. The documents reveal the extent and character of development decisions that are made. They also provide some insight into methods used and their strengths and weaknesses.

## Select Setting and Type of Training

The assignment of $AFC^2$ training to a particular location or situation is in large part dictated by tradition. In this there is both a strength and a weakness. Tradition tends to be based upon what works, a strength. On the other hand, tradition tends to be inflexible and does not provide for consideration of new, perhaps better, alternatives, a weakness.

Initial and advanced training of $C^2$ operators and support personnel takes place in resident schools and TAC resident training units. Transition and continuation training and system exercises take place in operational units.

Initial, advanced, and some transition training are characterized by formal courses whose development is discussed in this section. The remaining transition, all continuation and system training are primarily on-the-job. On-the-job training (OJT) is informal, involving individual participation in a certain number of intercepts or activities per month or quarter. System training involves unit participation in a certain number of exercises per month or quarter.

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Transition and continuation training for supervisors and battle staff is carried out on-the-job. OJT is a default training setting for these personnel because no initial training needs are established. It is traditional to advance skilled operators and support personnel into supervisory/staff positions. For example, weapons directors in a CRC come from the ranks of the weapons controllers. The OJT setting for training supervisors and staff works reasonably well for systems which have been deployed for some time because there is a pool of experienced individuals available. However, during system acquisition the tradition is not optimal because there is no experienced pool of operators, support, or supervisory personnel from which to advance individuals.

Development of initial training of operators and support personnel for new or modified systems is managed by ATC. There are four types of initial training development which ATC manages. Type I is developed and conducted by a contractor, usually the system developer/producer. The setting for Type I training may be the factory or the field, depending on the need for or availability of (training) equipment. The purpose is to provide a trained crew to man the system during development and operational tests and to train instructors who will carry out Type II and Type IV training. Type II training is carried out by ATC using contractor-developed draft materials. The purpose of this training is to meet the initial manpower demands of the new system. Thus Type II training is characterized by high throughput. Type III training takes place in resident schools. It is based on revised and validated course materials. The purpose of Type III training is to meet personnel replacement needs in the system life

cycle context. Type IV training is conducted at operational sites by ATC
mobile training teams. The purpose of Type IV training is to provide
a cost-effective means of accomplishing training in the field when dictated
by (training) equipment availability.

Some examples will clarify the relationship between setting and type of
training. All existing ATC courses for personnel are Type III. AWACS
training is a combination of Type III, formal ADWC/IWS, formal TAC
initial training, and OJT. In the case of JSS, Type I and Type IV training
will be used to satisfy system testing and some early site manning
requirements. Follow-on training needs will be satisfied by Type IV,
formal ADWC/IWS, and OJT.

System training is carried out under live or simulated conditions within
operational units. Although conducted within the context of formal exercises,
system training is primarily OJT and informal.

## Develop Training Objectives

Whereas training requirements analyses deal with the job, the development
of training objectives represents a shift in focus to the specification of what
skills and knowledge are to be trained. Objectives are statements of
performance requirements, conditions, and standards. Enabling objectives
may be distinguished from terminal objectives.

Inherent in the decisions made regarding objectives is a determination
of the entry-level skill and knowledge of the students. This determination
is relatively straightforward for all courses and training beyond the
fundamental ATC courses. However, entry-level skill requirements for
assignment to the weapons control career field have not been established.
There are no minimum scores on the Air Force Officers Qualifying Test
(AFOQT) or other capabilities or prerequisites which must be attained or
demonstrated by entrants into the ATC Air Weapons Controllers Fundamentals
Course. Enlisted entrants into the Aerospace Control and Warning Systems
Operator career field must achieve a score of at least 60 on the general
portion of the Armed Services Vocational Aptitude Battery (ASVAB).

In the Air Force, training objectives are documented in a CTS. The CTSs
for the ADWC/IWS APQ Air Weapons Controller Course and the JSS
Weapons Controller course are presented in Appendix C. The APQ CTS
is quite detailed; assumed student entry-level skills/knowledges are
those acquired during the Air Weapons Controller Fundamentals Course.
Team-oriented training objectives are implicit rather than explicit. The
JSS CTS is general; assumed student entry-level skills/knowledges are
those acquired during SAGE duty. Training for JSS is thus crosstraining
from one system to another. The overall objective of crew training has
not been analyzed in any further detail. There are thus no formal $T^2$
objectives for the JSS program.

The training objectives for AWACS Weapons Director initial transition
training have been documented separately in greater detail than that
found in the CTS. Table 11 presents a representative set of objectives
from this document. For each topic related to knowledge or skill, the

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## TABLE 11. EXAMPLES OF WEAPONS DIRECTOR COURSE (E-3A 00 C00 DX)

OBJECTIVES

1. Tactical Air Control System Radar Units

   (WEA:TCR) Be able to recall the name, acronym, and basic function of each of the TACS radar elements without error.

2. Non-Radar Air Support Coordination and Control Elements

   (WEA:TCN) Be able to recall the name, acronym, and basic functions of each of the TACS Air Support Coordination and Control elements and other non-radar TACS control elements. Also, recall their relative relationships in the system.

3. Inside the E-3A

   (WEA:E-3A) Be able to identify crew members by job titles when given their function.

   Be able to match the appropriate functional group with its major components.

4. Weapons Section

   (WEA:WEA) Be able to identify Weapons Section tasks and name the positions that perform the tasks.

5. Situation Display Console (SDC) Components

   (WEA:SDC) Name each of the major Situation Display Console (SDC) components and associate the components with their functions.

6. Category Select Switches

   (WEA:CAT) Associate the Category Select Switches with the displays they control.

7. SDC Checkout and Setup

   (WEA:SET) Check out and set up a Situation Display Console (SDC) including assigning the console to the proper function.

8. Switch Action Rules

   (WEA:RUL) Identify components of Input and Menu Lines, and ....

## TABLE 11. EXAMPLES OF WEAPONS DIRECTOR COURSE (concluded)

(PTP:SPT)   Given a list of special point symbols and codes,
create/display a special point type at any coordinate
or location, specifying a designator or DLRN,
heading, altitude, and speed (if appropriate).

Delete a special point from the system.

41.   Commit to Special Point

(PTP:CSP)   Use computer actions to conduct three simultaneous
radar monitor and/or control missions to a special
point target using specific approach parameters.
The aircraft will take off at three-minute intervals
after the special points have been entered into the
computer.

Verify the information contained in the data base for
assigned point-to-point missions.

42.   Point-to-Point Missions

(PTP:MSN)   Recall the basic functions of each of the point-to-point
missions and their components.

43.   Conduct Point-to-Point Missions

(PTP:CPM)   Given adequate mission briefings, conduct the
following point-to-point missions:

- Close-air support with FFAC and FAC-A support
- Close-air support with FFAC support
- Close-air support with ASRT support
- Interdiction
- Interdiction with escort
- Reconnaissance
- Airlift
- Psychological warfare
- Search and rescue

44.   Point-to-Point Handover Procedures

(PTP:HAN)   Conduct five simultaneous (individually controlled)
point-to-point missions, separated as briefed, but
not less than 1000 ft (2000 ft at or above ....

specific actions and conditions and some standards are described. As above, team-oriented training objectives are implicit rather than explicit. (See objectives 43 and 44 in Table 11).

The CTS may be viewed as a contract between the unit doing the training and the unit to which the individual will report next. The acquiring unit assumes that the required proficiency levels have been obtained. These levels become the basis for establishing training standards in the acquiring unit or in setting the criteria for accomplishing transition training. In the absence of a CTS, for example, in OJT, training objectives are not specified as such. Terminal objectives are specified as part of the standardization/evaluation testing program. Enabling objectives if they are specified at all are in terms of the number of live or simulated events and exercises which individuals and teams must participate in during a month or quarter.

There are no formal analytic techniques in use for determining individual objectives. Job experts and training developers specify objectives, including standards, through a discussion/negotiation process. The results of the process, except standards, are documented in a CTS.

The same sort of informal process is used to develop system exercise objectives. The appropriateness and precision of the system training objectives depend on several factors. Because the process is informal and dependent on the participating individuals' experience, training objectives per se may not be addressed for system exercises at all. If the group decides to develop training objectives, they may be constrained by available resources. For example, if it were desirable to make a live

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exercise extremely difficult, this may not be possible given the number of aircraft available or the types of jamming which can be employed in peacetime training.

In summary, the development of training objectives for initial and advanced training courses is documented in the form of a CTS. The process of development is based on job expertise. Training objectives are not developed for transition and continuation training. The training requirements regarding participation in a minimum number of live or simulated intercept events or exercises are not translated into objectives. The objectives for system exercises are developed informally, if at all, and are usually limited by non-training considerations.

Entry-level skills possessed by personnel depend upon previous courses and job experience. There are no minimum requirements or prerequisites for entry into the weapons control career field. In system acquisition, training objectives for Type I and IV courses are based on the previous job experience of the personnel to be trained. Thus, the levels of knowledge and skills which the students bring to the course, the starting point for training, is known with uncertainty and is probably heterogeneous.

## Determine and Develop Proficiency Assessment Techniques

Proficiency assessment is necessary in order to gauge trainees' progress, maintain quality control over course graduates, and provide a basis for upgrade in operational status. It entails the specification of relevant task dimensions and performance characteristics, and establishment of evaluative criteria. Feedback to trainees is inherent in the proficiency assessment process, but may be augmented by independent techniques.

The Air Force distinguishes between knowledge and skill components of proficiency. Knowledge concerns the facts, principles, and theories of the subject matter to be mastered. Skill refers to the actual tasks and duties which must be performed.

The measurement of performance is governed by the dichotomy of job proficiency components. Knowledge is measured using objective tests, usually of the multiple choice variety. In the case of duty-specific knowledge, oral exams may be used. Criteria for knowledge objectives are absolute rather than relative. For example, 90% on a test is passing, or an oral exam is satisfactory or unsatisfactory. Skill is measured by observation: experts evaluate positional performance. The format of the evaluation during training is precisely the same as the job performance measures discussed previously. The criteria for speed and accuracy of performance are not well documented; they are internalized by the expert based on job experience.

In $C^2$ there is a very close relationship between training objectives and standards as defined in a CTS, on the one hand, and the performance factors to be evaluated and criteria on the other. In the case of skills assessment, the translation from objectives to evaluation factors is straightforward, but tends to promulgate any shortcomings of the specified training objectives into proficiency assessment.

For example, team-oriented skills are evaluated implicitly rather than explicitly. Also, where no training objectives have been developed, as for supervisors and battle staff, performance measurement dimensions are based solely upon job/duty descriptions. These descriptions tend either to be quite global, for example, "supervision and teamwork and knowledge of local procedures" (see Table 10 for additional examples), or incomplete.

The survey discovered no evidence of efforts to develop proficiency assessment techniques specifically designed to evaluate team or system readiness or effectiveness. As discussed in the next chapter, in practice, expert judgment based on observation of team performance is the basis of team proficiency assessment; and system performance is measured, if at all, by the percentage of successful detections or intercepts/kills, or by expert judgment as to whether or not the mission was successful.

In summary, the determination and development of proficiency assessment techniques are adequate for individual performance of operators and support personnel, but have actual or potential shortcomings in the team skills area and for supervisors and battle staff. These shortcomings include the lack of explicit objectives and standards for team skills; use of global job/duties statement in lieu of training objectives, especially for supervisors and battle staff positions; the lack of assessment of team or system readiness; and a lack of documented standards. Feedback techniques are correlated with the methods of training and of proficiency assessment. Individuals receive feedback intrinsic to the tasks they perform and from the evaluator based on observations of performance. Teams receive feedback intrinsic to the mission they perform, including a debriefing after it has been completed. More will be said about feedback in Chapter III.

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## Select Instructional Methods, Media, and Sequencing

The performance dichotomy between knowledge and skill training objectives traditionally dictates the selection of academic training and positional or hands-on training activities, respectively. Selection of instructional methods requires decisions about the degree of individualization, type of instructional pacing, student/instructor ratio, and the like. Media selection involves specifying the precise means by which students will encounter instructional material, for example, lecture, film, simulation, etc. Instructional sequencing is selected according to relationships among the training objectives including commonality and dependence; enabling objectives must be met before terminal objectives.

Methods of instruction in $TAC^2$ are not selected by analytic means, but tend to be a function of course management structure or philosophy. For example, the ATC initial training courses are group lock-step or paced while the TAC initial, transition, and continuation training courses are self-paced. In ATC the class is viewed as the instructional unit: a class enters, is instructed, and graduates. In TAC the instructional unit is more often the individual and so the self-pacing method dominates. Also, the student-instructor ratio, which is maintained at between 2 and 3 to 1 throughout $C^2$ training programs, is a function of the master-apprentice model which dominates positional training. More will be said about this model in Chapter IV.

Although there are analytic techniques for determining media requirements, the survey found no evidence of their use. The media of academic training are consistent with instructional methods. Lectures augmented by written or sound/slide programs are universal in group and individual instruction. Interestingly, the same type of modularized programmed texts and sound/slide are used regardless of the type of pacing. This appears to be a byproduct of the application of criterion-referenced ISD to the development of academic training, and a tendency on the part of some training developers to equate the application of sound/slide programs with satisfying the ISD requirement.

The need for simulation as a positional training medium is a given for $C^2$ operators and teams. This situation appears to have arisen out of the need to exercise teams and evaluate system performance under simulated conditions. Live flying for such purposes poses problems of safety and limited resources, for example, planes and fuel. There is no analytic technique for determining the relative amounts of simulation and live flying optimal for training. Simulation on actual equipment has become a primary medium for accomplishing initial, transition, and continuation positional training and for conducting team/system exercises. The definition and development of simulation training are characterized in this chapter's final section.

Instructional sequencing is governed by commonality, dependence, and complexity for individual knowledge and skill. Team-oriented tasks are not subject to sequencing because they are not explicitly identified as training objectives.
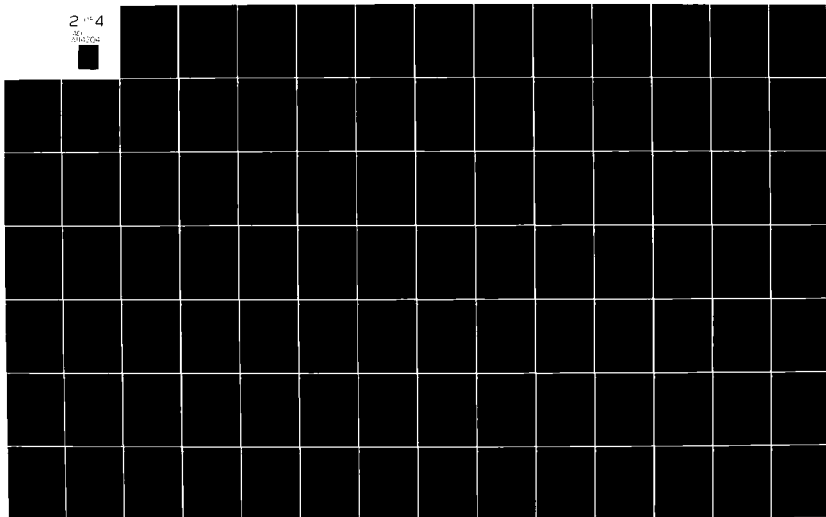
In summary, the selection of instructional methods, media, and sequencing is more a function of non-training factors like tradition, management philosophy, and constraints, or shortage of aircraft and fuel, than it is a function of training considerations. From the point of view of team readiness, the most critical aspect of this state of affairs is the degree to which simulation can provide adequate training and experience.

## Develop Plan for Program Management and Materials Production

The survey discovered that only during system acquisition was a comprehensive instructional management and production plan, the System Training Plan (STP), developed. The STP contains guidelines and actions required to implement ATC-controlled training; it is an outgrowth of Section 11 of the PMP as discussed earlier. There is no comparable single document developed for managing and producing transition and continuation training. Rather, the elements of such a plan are addressed through manuals, regulations, and separate CTSs and course descriptions.

The key features of a program management and materials production plan should be: 1) guidelines for the preparation of lesson content, 2) description of procedures for student management, 3) discussion of the selection, training, and roles of instructors, and 4) administrative information including class sizes, schedules, and training equipment needs. In short, the plan should document all relevant decisions made to this point in the training development process, plus additional information to smooth the transition to the training program. The STP and the operations training planning documents lack certain of these features. A description of both will highlight their strengths and weaknesses.

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The STP includes the following information, which is updated at six-month intervals during system development (Reference 15). It identifies the organizations involved in implementation and/or support of training and their responsibilities including authoring; it describes types of training required over the system life cycle, including plan for developing organic training support; it provides personnel data including numbers and types of students and instructors required and when; it describes the training facilities required to support training; it describes the required training program including courses, location, type, length, and start data, plus for each identified job, the training requirements; it describes the CTS and course chart (a description of the topics to be covered, their sequence and the length of time spent on each); it identifies the technical data needed to support training; and finally, it provides an overall training schedule based on system test and evaluation needs.

The STP does not specifically address student management procedures because ATC has standard procedures applicable to all training. The STP does not discuss selection of instructors or students beyond specifying entry-level skills for students. As noted earlier, the CTS (and the course chart) deal with team training requirements and objectives at a global level, if at all. Finally, training equipment and its capabilities are not discussed in the STP. These issues are normally addressed under the system development contract, as described in the next section.

TAC does not develop such unified plans dealing with the management of transition, continuation, and system training. The most representative sources would be TAC Manual 50-9 (Reference 5) and TAC Regulation 51-43, which deal with criteria and procedures to conduct the operations training program for TACS and AWACS, respectively. The operations training program consists of transition and continuation training for individuals, and simulated and live system exercises.

In these documents, individual requirements are stated in terms of minimum hours for subject area coverage (academic) and minimum number of hours of types of events or activities (positional) for all TACS personnel. Conditions under which these requirements must be met and may be modified are also given. Training objectives and other more detailed information are not included. Lesson outlines and plans are published by TAC HQ operations training offices. Because each operational unit implements these outlines and plans and each unit has local procedures to follow, the specific content of local operations training programs will vary, especially in the area of positional training and system exercises. However, TAC HQ publishes information guides for self-study and these guides are based on the TACS Stan/Eval Program; so training of the knowledge component of proficiency is standardized. The 4444th TACS/OTD ISD team is referenced in TAC Manual 50-9 and it is stated that their efforts will periodically result in new requirements and materials for training TACS operators. These replace existing requirements and materials as they are fielded.

Management of personnel in training status is thoroughly discussed.
Transition training is divided into two phases, in which the purpose of
Phase I is familiarization and Phase II is aimed at achieving operational
ready status. Continuation training is accomplished in Phase III. Phase IV
is a non-training status reserved for Unit Commanders, Chiefs of
Operations and Plans, NCOICs, and other high-level supervisors; all of
these personnel pass directly from completion of Phase I to Phase IV. Their
day-to-day activities are expected to maintain their operational readiness.

Personnel requirements for instructors are identified in terms of highly
qualified individuals who have demonstrated the ability to instruct and are
completely knowledgable in all relevant subject areas (Reference 5). This
approach seemed generally to be the case in practice, although highly
qualified and completely knowledgable people are becoming harder to find.
There is also competition for these people in operational positions.

System exercises are carried out under simulated or live conditions.
Provision is made in TACS for different categories of simulated exercises
and minimum training requirements in terms of frequency are established.
No specific requirements or plans are given for live system exercises.

The categories of simulated exercises depend on the scope of involvement
of TACS elements. Category 1 is training which exercises a partial TACS
varying from a single to several elements (for example, a CRC and
ASRT). Category 2 is a system netted training activity designed to fully
exercise interactions among all elements of the TACS. Category 3 is
training which exercises the TACC Current Plans Division (PLANEX).
The minimum training requirement for each category is determined by

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expert judgment and tradition which follows the SAGE model. Participation
in live exercises fulfills simulated exercise requirements on a slightly
better than one-for-one basis.

Guidance for participation in training in a live environment notes that such
opportunities usually arise in joint service exercises. It is the responsibility
of TACS units to coordinate with other services' $c^2$ systems to provide
live training opportunities. Such coordination is encouraged because
establishing the necessary data links makes the experience extremely
beneficial since these links would be critical in a theatre operation.

We discovered no comparable documents for the planning of large-scale
exercises although schedules are published yearly. Such planning is
usually accomplished in conferences which are attended by representatives
of participating elements and commands. These experts determine the
scope and objectives of the exercise consistent with its general purpose.
The exact details are based upon available equipment and personnel
resources and safety considerations. A scenario to drive the exercises
is devised through decisions based on professional judgment. Some
series of exercises are wholly simulated, while others combine simulated
(scripted) and live (flying) inputs. The definition and development of
radar and event-based simulated inputs are discussed in this chapter's
final section.

## Produce/Validate Instruction

The final steps in training program definition and development are the
production and validation of instruction. Instructional materials are
produced for academic and positional training. New materials are
evaluated and revised as necessary before actual use. These steps
are accomplished in essentially the same manner for all training programs
surveyed.

When a $C^2$ system is produced, if it is computer-based, then the government
can require the developer to provide positional handbooks--DI-M-3409/H-109-1
(Reference 16). According to the data item description, "positional handbooks
describe the operating procedures for consoles used to support the system
in accomplishing its prime mission." The emphasis of each handbook is on
the responsibilities, duties, and operating procedures required of the
operational position. The handbook is capable of serving as a primary
instructional tool for training operators of new systems. The survey did
not determine the extent to which this data item is or has been required on
$C^2$ system programs.

For initial and advanced training programs, instructional and/or subject
matter experts produce instructional materials with the assistance of
audio visual aid experts if necessary. These materials take the form
of plans of instruction, lesson plans, syllabi, programmed texts, and the
like. The content of these materials follows from CTSs, course charts,
and more detailed sources if they exist. These documents are universally
well-structured, clear, and complete insofar as previous analyses have
been thorough. Lesson plans and syllabi specify the subject matter topics

and objectives, and conditions under which demonstration and practice of positional skills take place. Their purpose is to ensure that all students are exposed to a minimum standard set of problem types and procedures.

In operations training programs, materials beyond those provided by TAC HQ may or may not be produced at the discretion of the unit operations training officer. SAGE Regional Control Centers each produce their own materials within the framework of the ADCOM-established requirements and objectives. Operational TACS elements and AWACS squadrons which have intensive initial transition training programs work with the HQ-provided materials.

Instructional materials, per se, are not produced to support system exercise programs or large-scale exercises. Briefing materials are written by exercise planners. The briefings establish conditions and objectives in the form of mission requirements, thus initiating the exercise scenario.

Under ideal circumstances all instructional material produced as part of ISD is subject to a tryout, a simulation, with a sample of individuals representative of the student population. Rarely does the Air Force have the luxury of evaluating newly-produced materials in this manner. Initial validation of materials is by approval of HQ SMEs. Evaluation and modification of instructional materials result primarily from use in training.

# TRAINING DEVICE DEFINITION AND DEVELOPMENT

This section summarizes our major observations regarding the definition and development of $AFC^2$ training simulators and simulation exercises that were observed during the site visits. The principal simulations observed were:

- Manual radar sets (UPA 35 and 62)

- SAGE

- CRC/CRP/TACC

- BUIC

- AWACS

Basic weapons controller training (Tyndall) is supported by manual radar consoles that are stimulated with prerecorded simulated radar returns (T-2 tapes) and interactively controlled simulated tracks (T-4 tracks). The T-4 tracks are controlled by enlisted personnel who play the role of interceptor pilots (T-4 drivers). Up to four T-4 tracks can be controlled by one T-4 driver, and 12 tracks can appear on one display. T-4 tracks can be overlaid on top of T-2 or live radar imagery. The student console is manned by the student controller and another student who is playing the role of weapons technician. The instructor and students are in two-way communication with the T-4 driver who mimics the verbal responses of a pilot who has received directions from the controller.

The SAGE simulation exercises (Luke AFB, Duluth) were conducted in operational SAGE centers and exercised the entire $C^2$ team. The scenarios involved attacks on the continental US by manned bombers, and the role of the $C^2$ team was to detect the attackers and direct interceptors against them. The scenarios were presented in the form of prerecorded tapes that stimulated operational SAGE equipment.

The CRC/CRP/TACC exercises were multisite events that involved a CRC (Eglin), TACC (Shaw), and a number of ancillary units. Events on operational CRC scopes were portrayed by T-2 recordings and T-4 tracks. Communication links were established between participating sites. Some participants in the $C^2$ network were played by script readers who provided prepared verbal inputs at specified times within the exercise.

The BUIC simulator (Tyndall) is used in an AQP course that is designed to transition student weapons controllers from manual to automated radar systems. The simulator consists of operational BUIC equipment stimulated by systems that are functionally comparable to the T-2 and T-4 systems.

The AWACS simulator (Tinker) includes nine operational mission crew consoles (situation displays) and a computer display maintenance operator display (CDMO) in a room that resembles the interior of the E3A aircraft, as well as interceptor pilot simulator (IPS) consoles (similar in function to T-4 driver stations) in an adjacent room. Simulation exercises use prerecorded (T-2 style) tapes in conjunction with interactive (T-4 style) tracks to stimulate operational equipment.

In all systems the instructors monitored, assisted, and evaluated student performance by standing behind the students and watching the display and the operator's actions.

In all cases the physical fidelity of the simulators was excellent because operational equipment was used. Serious problems were observed in the utilization of the simulators for training, however, and these problems are discussed in detail in the remainder of this section. It is our opinion that most of the problems have resulted from the failure of the simulator definition and development process to coordinate with an expanded ISD process. Therefore, our discussion is organized around four major steps that may be abstracted from the ISD framework:

- Functional analysis

- Partitioning of functions

- Definition of training device requirements

- Development of a training device

By organizing the discussion in this way we intend to underscore the major steps which in our opinion should be followed in the training device definition and development process. Most of the simulations cited above were developed before ISD processes were formalized. Even the AWACS simulator, which is the newest one we observed, was initially designed early in the history of the ISD model although the most recent copy of the simulator was delivered in 1980. Thus, it is not surprising that many

of the guidelines discussed herein were not followed. Our purpose is not to demonstrate the quality of hindsight, but to document lessons learned so that future $AFC^2$ simulators will provide higher-quality, more cost-effective training.

## Functional Analysis

Functional analysis is related to the job or task analysis produced in ISD. The goal is to identify and define the functions performed by the operator in the course of his job. Examples of operator functions in $AFC^2$ systems include interpreting radar imagery, selecting an appropriate display scale and center, performing range and bearing computations, and guiding an intercept. A functional analysis identifies and defines the stimulus conditions and information the operator must act on and the procedures he must follow. The analysis should be broader than the details of the software and hardware of the system, and should include a consideration of the tactical environment in which the system will operate. Examples of relevant factors are the density and capabilities of own and threat forces, combat tactics, and tactical mission.

We have no direct data bearing on the types of functional analysis that were performed, if any, in the design of the simulators we observed, but the reports of interview respondents indicated that the analyses were either not performed or, at most, were conceived narrowly. The set of simulator functions was, in general, apparently defined in terms of the actual system. This is particularly understandable because all systems utilize operational equipment stimulated by simulated radar returns. The problem with this approach is that operational variables affecting operator functions were sometimes overlooked.

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An example of this problem is apparent in the T-2 system, which presents prerecorded radar imagery. Because the imagery is prerecorded it is noninteractive. The operator cannot talk to simulated pilots and observe responses on the scope. Thus, although the scope and function keys function realistically in the simulation, the operator's communication functions are not serviced. The T-4 system alleviated this problem, but the problem illustrates difficulties that can arise from an insufficient functional analysis.

The T-4 system in fact provides another illustration of this problem. When the T-4 was developed the F4 and F106 represented the state of the art in interceptor capabilities. The T-4 includes flight dynamics models for these two aircraft, but it is not feasible to modify the T-4 to model more advanced aircraft (F15, F16) that have been developed since then. As a result students are often surprised by the extreme responsiveness of advanced fighter aircraft when they see them for the first time in live missions. A thorough functional analysis would have noted that the simulator should be capable of depicting a variety of aircraft, and the data base containing aircraft dynamics models should be conveniently modifiable by instructors (who are not computer or electronics professionals) as developments occur.

A further example may be drawn from the AWACS simulator. One responsibility of the AWACS surveillance team is to detect and respond to electronic warfare (EW) interference with the radar picture. The simulator is capable of presenting various forms of degraded imagery, but not in an interactive manner. The ideal situation would be for EW interference of

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various types to occur when requested by the instructor. The time required by the surveillance team to detect and counteract the threat would then serve as measures of team performance. Such an approach is not feasible with the present system, however, because EW effects cannot be switched on at will and operator inputs will not correct the problem even if the inputs are appropriate.

The examples above focus on the problem of identifying relevant problems for individual operators (although the EW example applies also to teams). A final example illustrates the importance of including team functions in the functional analysis. The AWACS team (mission crew) includes surveillance, weapons, support, and supervisory personnel. The AWACS simulator includes consoles for all crew members except the support personnel (communications operator, radio operator, computer display maintenance operator, airborne radar technician). As a consequence, important coordination exercises that involve these crew members can only be performed in airborne exercises--the cost and training effectiveness benefits of simulation cannot be applied to such exercises.

The design of the instructor station and the capabilities provided for the instructor to interact with the system and trainee are inadequate. Little attention was given to any kind of analysis of the instructional techniques to be used, the functions of the instructor in using them, and the information he would need. The existing instructor station is over the student's shoulder. The lack of an adequate instructor station seriously limits the effective use of the training device.

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## Partitioning of Functions

After the individual and team functions of a system have been identified
and defined in the functional analysis, they should be partitioned into two
classes:

- Functions to be trained in the simulator

- Functions to be trained through the use of other training
  media

The criteria for sorting the functions in this way are complex and treated
in formal ISD documentation. This step in the training device definition
and development cycle is related to ISD media selection analysis procedures,
which are intended to identify the most cost-effective training medium for
each operator or team function. Because training simulators are very
expensive, other media should be selected whenever possible. This will
minimize the set of functions to be simulated, thus reducing development
costs, time, and technical risk.

The main point of the partitioning analysis is that the sorting should be
based on training criteria. The evidence from our observations and
interviews suggests that the partitioning has historically been based on
other criteria. The usual practice has been to define a method for stimulating
operational equipment. Functions that could be exercised with this approach
were assigned by default to the simulator for training. The problem with
this approach is that functions that could potentially be trained more
effectively with other media are trained on the simulator instead. This
has the unfortunate effect of using an expensive, scarce resource to train

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functions that may be trained more effectively in other ways. In addition, the added capability required to simulate such functions can add unnecessarily to the acquisition and life cycle costs of this simulator.

Another difficulty with the historical methods for partitioning functions has roots in the failure to perform adequate functional analyses. This is the increased probability that functions that should be simulated will not be because they were not identified in the functional analyses.

## Definition of Training Device Requirements

The functional requirements for a training simulator may be grouped into three broad categories:

- Operator interface functions

- Tactical environment models

- Training support functions

Operator interface functions include operator-console transactions. These functions are identified in the functional analysis and have typically been well-defined in the simulation systems we observed. Tactical environment models include the algorithms and data base depicting capabilities, numbers, and geographical distribution of Red and Blue forces, aerial combat tactics (engagement models), airspace regulations, ECM/ECCM conditions, terrain features, weather conditions, time of day/night, and so forth. These models should be defined on the basis of the functional and partitioning analysis. The models were defined to some extent in the models we observed, but not to the extent deemed necessary by the instructional developers, instructors, and students we interviewed.

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The first two categories are sufficient for defining a simulator but not a training device. A training simulator is a part of a larger training program, and it should therefore include features that are designed explicitly to support training functions. Examples of such functions are:

- Automated assessment and monitoring of operator and team performance

- Presentation of performance data to instructors

- Automated branching among lesson segments on the basis of student of team performance

- Automated delivery of feedback and prompting to students and teams

- Capability for simulating events in real time and at rates other than real time

- Capability for replaying simulated events

- Part-task training capabilities--the ability to exercise a subset of the operator's or team's duties

- Capability for presenting successive approximations to the quality and appearance of imagery on a display scope

- Flexibility, ease of maintenance, and convenient modifiability so that instructors who are not computer professionals can make necessary changes in the data base and models driving exercise scenarios

The first four features are nontrivial in that they require advances in the state of the art in performance measurement. This problem is especially serious in the context of team training. The next several features pose difficult software problems, but they are problems that have been solved in other simulation and CAI applications. The final feature references a general need for human factors analyses directed at improving the interface between the instructor and the training system. The set of features is intended to emphasize that the simulator or training device should be a tool for instructors to use in achieving the training objective of a training program. It is not sufficient for a simulator to be just a faithful replica of the operational system--it must also support training functions per se.

None of the simulators we observed included significant training support functions. Some of the systems included consoles for intercept pilot simulators (for example, T-4 drivers), but these people are not involved in the planning, control, or assessment of training. In the manual training system at Tyndall, for example, the instructor must literally stand behind the student who is working the scope, and he must watch the student's every move (especially during early training). This level of instructor attention may be appropriate during live missions when safety is of paramount concern, but many of the instructor's functions could be automated in simulation exercises. This would free the instructor to perform more important duties. The equipment at Tyndall is old, but newer simulators follow the same approach. As one course developer remarked about the AWACS simulator, the newest of the systems we observed, the instructors must still rely on just "their eyeballs and a piece of paper" in assessing and recording individual and team performance.

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## Development of a Training Device

Training device development follows directly from the preceding analysis and definition steps. This is largely a software and hardware engineering problem and does not require discussion here except to recommend that training and human factors specialists should be kept in the loop throughout the design process. The purpose of the participation is to monitor the design process, provide inputs for decisions that affect the student/system, instructor/system, and student/instructor interfaces, and defend the training and human factors philosophy when necessary. The problems with current $C^2$ simulators demonstrate the need for input from these specialists early and on a continuing basis during the simulation development process.

CHAPTER III

STATUS OF AFC$^2$T$^2$ PROGRAMS:
IMPLEMENTATION AND MANAGEMENT

OVERVIEW

The success of the training mission is determined by the relevance of the skills trained to the skills required, the effectiveness of the methods used to conduct and evaluate training, and program management. The survey of TAC$^2$ training revealed both strengths and weaknesses in the skills trained, methods of training and assessment, and program management. Some of the weaknesses follow from weaknesses of training definition and development. Others are unique to the way in which training is conducted and managed.

Discussion of the strengths and weaknesses in AFC$^3$T$^2$ implementation and management is organized around five topics. The skills trained and program management are treated separately, and methods of training and assessment are divided into three parts. This chapter is therefore divided into five sections, as follows:

- Individual and team skills trained

- Instructional strategies and sequencing

- Simulation/simulator features and utilization

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- Assessment of team and system performance

- Program management issues

A brief summary of the contents of each section follows.

The individual and team skills being trained in $C^2$ training programs are described in the first section. It is argued that team skills as properties of the team as a whole do not exist. Team skills are best understood as individual cognitive skills required for carrying out interactions with other team members. The training of team-oriented cognitive skills is unstructured and unsystematic, because the requirement to train them is not made clear during program definition and development.

The important instructional methods of $C^2$ training are the master-apprentice model and role-playing. The master-apprentice model has strengths and weaknesses that were identified. The latter are especially evident in informal training, that is, OJT. Role-playing techniques are used to good advantage in formal training programs. There is little sequencing of training individual and subteam skills, as subteam skills are fundamental to the $C^2$ console operator tasks, especially those of the Air Weapons Controller (AWC). Team and superteam skill training follow individual and subteam skill training, but are themselves not carried out sequentially. The AWACS training program is subject to the most sequencing problems as a result of mission variability and uncertainty. That is, given the worldwide potential commitment of AWACS and the multitude of possible mission scenarios, it is difficult to determine which system exercises or simulated combat missions to train initially, and so on.

Simulators and simulation are used extensively in $AFC^2$ training programs. The invaluable role of simulation in $AFC^2$ training was acknowledged by all survey respondents. However, several serious problems prevent simulation from being as effective as it could be. Current simulations lack tactical realism in terms of the characteristics of the projected threat and in war-gaming, that is, interactive capability. Geopolitical relevance of simulations based on past conflicts is low. Simulators lack features and capabilities supportive of the instructor interface.

The assessment of team readiness and system effectiveness is difficult, incomplete, and hampered by non-training factors, like the unavailability of live flying resources or the inability of current simulations to model a European theatre conflict. The conditions under which teams are evaluated vary widely.

Individual team-oriented skills are assessed in a global fashion only, but the team performance process is observed and feedback based on these observations is delivered both orally and in writing. System effectiveness measures do not take the difficulty of exercises into account. Political pressure sometimes keeps operational problems from surfacing.

Finally, issues of program management concern problems in $C^2$ career fields, resulting in low retention rates and the steady loss of experienced individuals. There also are problems specific to specific programs: Training managers do not appear to have an adequate understanding of the $C^2$ training pipeline, and the training implemented for newly acquired systems does not always address the needs of inexperienced personnel.

## INDIVIDUAL AND TEAM SKILLS TRAINED

It is generally agreed in contemporary psychology that there are two broad categories of skill, namely, perceptual-motor and cognitive (References 17 and 18). Both of these categories can be more finely divided. The survey of $AFC^2T^2$ indicated that the following types of skills are being trained either formally or informally:
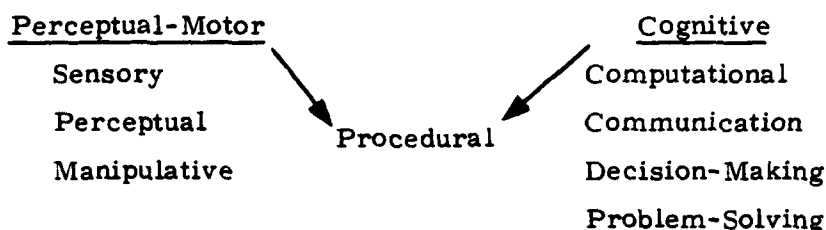


Perceptual-motor skills[1] are required in the detection and interpretation of radar imagery and in operation of the display console. Procedural skills are a hybrid of perceptual-motor and cognitive skills; they are required to properly operate equipment and to perform any task involving a preferred sequence of events and actions. Cognitive skills involve the mental processing of information and knowledge and are required in tasks that demand thinking.

Cognitive skills form the foundation for efficient and effective team performance. In $C^2$ tasks the paramount requirement is the timely delivery of information to a teammate. The particular information that gets

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[1] Knowledge of the $C^2$ system, Air Force and TAC policies, procedures and tactics, and the threat is a prerequisite to acquisition of skills.

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communicated usually is a product of other cognitive skills like computation, decision-making, and problem-solving. It is the timing of one's own actions and the anticipation of a teammate's needs or actions which produces the coordinated behavior of a team.

An individual's cognitive skills are the only ones identifiable as team skills. Team performance is a byproduct of the execution of individual skills in a team context. As long as every individual team member is proficiently performing team-oriented skills, the team performance that is observed will be proficient. Because of the interdependencies in team performance, if one individual is unskilled, his teammates will have to adapt, or team performance will suffer.

One of the implications of this view for identification of a "good" team is that assessment should proceed on two levels. First, tests of individual team-oriented behavior should be developed, and second, it is important to focus on the process in evaluating team readiness.

Also according to this view, team-oriented skills at times compete with perceptual-motor or procedural skills for the attention of the individual. Thus, another aspect of skilled performance, time sharing, is important in $C^2$ tasks. The time-sharing requirement of team-oriented skill may account for the observed decrement in individual proficiency that occurs when an individual performs in a team context.

It will be helpful to provide some examples of how these types of skills characterize the tasks and duties of the three $C^2$ personnel categories.

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## Console Operators and Support Personnel

The primary source of job-relevant information for surveillance, height, tracking, air traffic control, airborne radar and weapons technicians, and surveillance/RICM officers and weapons controllers is a display of radar imagery. The imagery may be either raw or processed, depending on the type of system--manual or automatic. To the untrained eye the data presented in such a display are at best so many stationary or moving blips. To the trained eye this data is information indicating the relative positions and movements of airborne objects. The display presents a "God's-eye" view of activity in a particular airspace. ATC instructors in the Air Weapons Controller Fundamentals course state that it is difficult for students to attain this "looking down" perspective on the display.

The surveillance and tracking technicians must learn how to detect data representing actual aircraft so that the aircraft may be identified, classified, and their movements tracked. In automatic $C^2$ systems, the technician must manipulate a control, for example, a trackball, to inform the computer of the location at which a target has been detected. The difficulty of the detection task is compounded by the long hours which may be spent on-station; vigilance is hard to maintain. This difficulty is more characteristics of SAGE (JSS) and a deployed control and reporting center/post (CRC/CRP) than of AWACS, which stays on-station as long as fuel is available. Height and tracking technicians learn how to extract information from the display regarding height, speed, and direction of movement. These tasks are supported by the system computer.

The sensory and perceptual skills of the surveillance/RICM officer, and weapons controller, also are applied to display data, but the tasks require a higher degree of pattern recognition than those of other console operators. In the case of surveillance/RICM officers, types and patterns of electronic jamming or other interference must be recognized (and defeated). Weapons controllers must recognize tactics of target tracks and discern trends in movement of friendly and hostile tracks. Although these sensory and perceptual skills are not easily acquired, there were no indications of special problems beyond the initial difficulty some students have adopting a God's-eye view of the display.

Manipulative skills for both job positions involve the use of input devices like trackballs, keyboards, or push buttons to keep the system computer current and to call up various display aids.

The sensory and perceptual tasks of console operators are complicated by two additional factors: amount of air traffic and familiarity of airspace location. The speed and accuracy of manipulative tasks are complicated by hardware (for example, AWACS keyboard) and software (for example, number of inputs required) design.

In SAGE/JSS the volume of air traffic is somewhat dependent on the region but tends to be uniformly high. A CRC/CRP or AWACS is subject to varying amounts of air traffic depending upon, among other things, the tactical situation and deployment location. In sum, SAGE/JSS has high air traffic volume, but a stable location with a familiar background of displayed noise; on the other hand, TACS elements and AWACS have unpredictable air traffic volume, and changing locations requiring adeptness at filtering out irrelevant radar data.

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As for manipulative tasks, good system design can make training and operation much simpler. The selection of functions to be performed by man versus machine, and the representation of machine functions in terms of keyboard layout and number of switch actions, both impact the ease of skill acquisition and the quality of performance. For example, some table updates in AWACS could be accomplished by machine; without a technician the controller is occasionally too busy to enter tabular information. AWACS also provides an example of the training impact of a poor keyboard layout (see Chapter 3 Overview). The profusion of TSQ-91, OJ-108 console function switches, and their occasionally incompatible arrangement, places a critical limit on the speed of performance.

Procedural skills are required in all console operator positions. Training for procedural tasks is easily developed and such skills are readily acquired. Procedural performance is rapid and accurate provided that the task occurs with regularity. Infrequent procedural tasks are typically performed less rapidly and accurately than frequent ones. One example of this skills maintenance problem was found in AWACS training. Interservice $C^2$ system exercises have not been frequent. Consequently, such exercises are characterized by poor performance of procedures for linking AWACS to Navy elements and aircraft using tactical data link A (TADL-A).

Procedural tasks requiring timely reporting of information to teammates or supervisors (for example, during an aircraft handover) involve the acquisition and performance of team-oriented skills. Little is known about the decay of these skills, but the necessary anticipation or timing is observed to be lost first while the sequence of actions is remembered for long periods of time. The decay of team-oriented skills is very probably one of the sources of ineffective team performance.

The tasks and duties of $C^2$ system technicians (except weapons) do not depend heavily on cognitive skills, although there are requirements in the areas of decision-making and communication. Important or unusual information should be brought to the attention of the technician's supervisor or other team member. The criteria for taking this action are not always clearcut and may change as a function of emergent, unpredictable properties of the task environment. There is no significant requirement to develop and maintain mathematical or significant problem-solving skills.

Cognitive skill acquisition and maintenance is critical to successful performance by weapons controllers/technicians and surveillance/RICM officers. Furthermore, these skills are almost always team-oriented and have a tremendous impact on team performance.

Computational skills are required to solve problems of algebra and geometry. Such computations are necessary to provide information that will yield, for example, an intercept course heading or speed. It is useful to distinguish between mathematical and computational skills, where the former are basic to a wide range of situations and the latter are those required to solve task-specific problems. Mathematical skills then are the foundation for computational skills. Respondents in the survey commented that it was difficult to train computational skills because many of the students did not possess the requisite mathematical skills.

Communications skills are essential to any interpersonal interaction. They vary in complexity from learning and using a brevity code in radio transmissions to speaking and listening or writing. These skills are vital to any team performance, especially the team formed by the weapons controller, technician, and pilot. The controller must communicate certain information to the pilot at the right time and in the right way. The technician must provide information to the controller, or other technicians, meeting these same criteria.

The particular information that is passed to the pilot by the controller depends upon many factors. Determining what information to communicate to the pilot demands decision-making and, occasionally, problem-solving skills on the part of the controller; good controlling is more a matter of technique than procedural skill. For example, effective control of aircraft requires anticipation of information needs based upon the current position, the desired position, the rate of change, the type of intercept, and so on. Improving the air picture is a problem that all surveillance/RICM officers must solve. Problem-solving and decision-making come into play when non-standard or unfamiliar situations occur and available standard procedures do not apply. The individual must then diagnose the situation, identify a goal or objective which will be responsive to the needs of the situation, adapt his skills to devise a sequence of actions to accomplish it, and then execute that sequence. He will often have to do this thinking and planning concurrently with executing the action. These behaviors are characteristic of the demands placed on individuals in emergent situations. The emergent nature of the tactical and air defense $C^2$ environment creates the need to train such higher-order cognitive skills.

No team can be effective unless the individual team members are highly practiced and skilled. Furthermore, team-oriented individual skills like communication, decision-making, and problem-solving are critical to the acquisition of team skills, which in $C^2$ systems are primarily related to the interdependence between and among individuals for the timely transmission and receipt of correct information. Weaknesses in training these individual team-oriented skills negatively impact team skill acquisition.

## First-Line Supervisors and Battle Staff

The individuals trained for these positions already possess (or are assumed to possess) the skills of console operators and support personnel in their career field. The important individual skills are cognitive, with management and leadership skills being added to those previously identified.

Skilled team supervisors and staff are critical to effective team performance. For example, a Senior Director on AWACS or a Weapon Assignment Officer in a CRC/CRP must ensure that the work distribution among controllers (directors in AWACS) is equitable. Higher-level supervisors and staff are likewise responsible for the management of various resources to ensure that no portion of the team is overloaded or overcommitted. Thus, in the team environment all individual skills of supervisors and staff should be viewed as team-oriented skills without which the team will not perform effectively. Any weaknesses in training these skills are reflected in team performance.

Current practice in training supervisors and battle stuff is informal, unplanned in terms of training objectives, and unsystematic in coverage. No formal training is defined and developed for these positions. The learning by an individual is largely a function of the richness of the exercises so that he can be exposed to a wide variety of representative events, and his perceptiveness in attending to, recognizing, and remembering relevant things. This situation is very chancy. The acquisition of team-oriented skills will be haphazard and incomplete as long as this informal, unsystematic approach is used.

## INSTRUCTIONAL STRATEGIES AND SEQUENCING

The formal methods used in $TAC^2$ training vary in terms of the technique of instruction and the conditions of practice. The major instructional technique follows the master-apprentice model; another important technique used is role-playing. The best $T^2$ technique in use consists of intrateam briefings. The conditions of practice include simulated intercepts, simulated combat missions, and system exercises varying in scope and complexity. OJT is an example of an informal training method that depends critically upon the conditions of practice. There is some sequencing of individual and team-oriented training in initial training programs, but there is little sequencing of training in operations training programs.

### Master-Apprentice Model

The master-apprentice model is the dominant instructional technique in $TAC^2$ training. It is used both in formal and informal training for all

personnel categories. The model is characterized by an instructional
method consisting of three steps: 1) task explanation and demonstration by
the master, 2) performance by the apprentice, and 3) feedback to the
apprentice based on the master's observations.

This method is necessary for training skills, in general, and cognitive
skills and technique, in particular. However, the effectiveness of the
method is limited by certain inherent problems which may be exacerbated
by factors related to the training environment and structure.

The model assumes that the master is an expert performer, and, further-
more, that he has knowledge about the important aspects of his tasks and
performance. Expert performers are recognized by other experts fairly
readily, although the subjective nature of this evaluation has its own
shortcomings. Unfortunately, experts do not always have insight into
how they do what they do. Nor do all who occupy expert positions have
expert qualifications. Some aspects of expert performance may not be
accessible to examination.

The accessible aspects of an expert's performance must be communicated
to the apprentice in such a way that the apprentice can learn. In short, the
expert must be able to instruct, and do this regardless of the conditions
of practice and the structure, stage, or setting of training. These require-
ments pose few problems in ATC resident training, where instructors
receive special training; the structure is fairly well developed, (that is,
lesson plans) and the conditions of practice are relatively straightforward.
However, in TAC resident and operations training programs, where
instructors may have no training in instructional techniques and the

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structure and conditions are highly variable, the master-apprentice model can be ineffective or negative. In any setting, controller training, because of the importance of technique, is difficult to standardize; each instructor stresses different things dependent on his own technique.

OJT in a live environment represents a worst-case example of the problems that can be caused by applying the master-apprentice method in an unstructured setting. AWACS Mission Crew Commander (MCC) student respondents commented that the duties of their position are not clearly established and consequently, MCC instructors teach different job tasks dependent upon their own experience. Because of the importance of leadership and management skills, this lack of standardization, which can be expected to exist in any OFT setting where training material is lacking, can cause severe problems in team (especially soft teams) performance. As one SAGE student Senior Director put it, "Trying to learn how to be a Senior Director from a manual is like trying to learn English by reading the dictionary."

## Role-Playing

This method of instruction, in which students alternate between different positions, is used to good advantage in initial training programs. In the Air Weapons Controller Fundamentals course, students work together in groups of two or three. They take turns being the Weapons Technician and, as a consequence, learn the duties of that team member. This technique is also used in the manual SQT and APQ courses. In the fundamental Aerospace Warning and Control Technician courses students work in groups of four and rotate among the positions of surveillance scope operator, teller, plotter, and recorder.

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The only possible drawback in using this technique might be for training AWACS Weapons Directors who work without Weapons Technicians. However, student WD respondents indicated no problems arising from this practice. This instructional technique is a strength in $TAC^2$ initial training programs.

## Intrateam Briefings

A very effective technique for accomplishing $T^2$ is the use of intrateam briefings. This technique is used in the SAGE and AWACS training programs. Intrateam briefings consist of presentations by one section, for example, surveillance, to the rest of the team regarding that section's role and responsibilities. These presentations are independent of pre- or post-mission briefings. Such presentations can do much to enhance team awareness and structure a shared plan, both critical elements of team performance. Intrateam briefings were not observed during the survey. The specific nature of those presentations is therefore not known. It is our opinion that frequent, well-structured briefings are an $AFC^2T^2$ program strength.

## Conditions and Sequencing of Training and Practice

The basic job tasks of $C^2$ personnel are not in and of themselves inordinately complex. Rather, it is the nature of the operational environment in which the tasks must be performed that makes them difficult. Theater operations are characterized by unpredictable events and matters of life or death. The goal of $C^2$ training is to prepare individuals and teams to function efficiently in such environments. Even the conditions of a live-flying large-scale

exercise environment can only approximate the conditions of a theater operation. In this sense, all military training is carried out under conditions of degraded fidelity, but some conditions can be made more realistic than others.

A strategy for determining and implementing the conditions of training must not only specify the level of fidelity of various environmental dimensions, but must also specify the order in which different performance contexts are to be experienced. If the strategy fails to define conditions and sequencing, team-oriented skill acquisition will be haphazard and the quality of team performance in an operational environment will be highly variable. Conditions and sequencing of $C^2$ training and practice are not always well implemented.

As discussed earlier, the $C^2$ training performance context may be individual, subteam, team, or superteam. Team-oriented skills are important in all but the individual context. Both the emphasis on and level of team-oriented skills change from one performance context to another more inclusive one. Communication is a paramount subteam skill, but decision-making and problem solving tend to be more critical in team and superteam contexts. The dimensions of performance context which affect the level of skill required include the type of environment, live or simulated; the number, characteristics, and missions of aircraft (resources) being controlled; the amount of ECM and communications jamming; and the number, flexibility, and tactics of hostile aircraft.

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In initial training the complexity along these dimensions is minimal, but is sequenced and increased within each course. For example, AWC subteam skills are first trained in a simulated intercept environment with one friendly and one hostile (referred to as a 1 v 1 intercept), and predetermined tactics. When the student completes an initial progress check, he moves on to a live 1 v 1. As training continues there is no substantive increase in complexity of simulated and live intercepts. At the completion of fundamental SQT the student can safely perform most parts of a live 1 v 1 intercept using different tactics. The primary team-oriented skill which has been trained is communication; there is a minimum of decision-making and problem-solving needed at this stage. APQ training provides additional practice on subteam communication skills, and increases intercept difficulty to 2 v 1. At the completion of training the student can safely perform a live 2 v 1 intercept with some prompting on how and when to perform the task, especially in non-standard situations.

The details of team and superteam training conditions and sequencing differ according to the $TAC^2$ system. For example, the CRC/CRP-bound student controller receives additional practice on subteam skills at the 607 TCTS before entering an operations training program to practice in team and superteam contexts. On the other hand, the AWACS student controller begins practice in a team, and occasionally a superteam, context shortly after beginning initial transition training at the 966 AWACS Training Squadron; subteam training continues during this period as well.

The operations training program which follows for both systems is primarily concerned with training team and superteam skills. However, subteam skill training also takes place, because each higher-level context includes all those below it; all individual and team-oriented skills are practiced in a superteam context.

The conditions of controller subteam skill training are presented as part of a live or simulated intercept event. The conditions of controller team and superteam training are presented as part of a simulated combat mission, that is, exercise, which may or may not include live flying.

Exercises are more difficult to define and implement than intercept events. This difficulty is compounded by mission variability and shortage of live intercept events. The SAGE wartime mission is relatively straightforward; exercises for SAGE thus are spinoffs of a single prototype. The TACS wartime mission is complex and the development and implementation of exercises must take this complexity into account. AWACS represents a worst-case example of mission variability which produces a correspondingly large number of possibilities for simulated combat missions.

The number and complexity of exercises is subject to resource limitations. Consequently, it is impossible for AWACS team and superteam training to be adequately representative of possible mission requirements. Furthermore, the sequencing of this training is unsystematic. AWACS "piggybacks" on scheduled SAGE and TACS exercises when possible or arranges superteam training when necessary to achieve operational objectives, for example, the development of an Airborne Tactical Control System (ATACS, AWACS, and ABCCC), or linking with the Navy via TADL-A.

Thus, individual and team participation in any particular exercise is a function of timing rather than skill level achieved. Because the AWACS simulator, as discussed in the next section, does not have a full team simulation capability, it is not capable of providing a solution to this problem. This problem is compounded by the lack of hard crews in AWACS. Individuals who have seldom worked together before, who therefore lack certain team-oriented skills, may find themselves in a situation requiring superteam skills. This provides for a suboptimal training experience.

These types of problems are evident in TACS to a lesser degree than AWACS, but they still exist. Limited numbers and complexity of exercises pose a representativeness problem, but full team simulation capability mitigates this somewhat. Turnover in personnel may make individuals subject to sequencing which is inconsistent with their level of experience.

SAGE is probably in the best shape on this issue because of its well-defined wartime role and long history of fine-tuning exercise conditions. Sequencing for individual team members can still pose some problems, however.

## SIMULATION/SIMULATOR FEATURES AND UTILIZATION

Simulators and simulation exercises are used extensively in $AFC^2$ training programs. The training devices are used for initial and advanced training of individual operators and $C^2$ teams. All participants we interviewed--instructional program managers/developers, instructors, and students--agreed that simulation plays an invaluable role in current

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programs. The participants also agreed, however, that serious problems prevent simulation from being as effective as it could be. These problems have their roots in the training device definition and development process (see Chapter 2), and have a direct impact on the quality (cost effectiveness) of $AFC^2$ programs. The following points summarize the concerns of the people we interviewed:

- Insufficient tactical realism

- Low geopolitical relevance

- Lack of training support functions

- Inability to effect improvements in the training devices

The problem of insufficient tactical realism takes two forms. The first is that no current simulation exercises match the projected threat either in terms of numbers or capabilities. Live exercises are even less satisfactory because air traffic densities are lower than in simulation exercises. This is true even of exercises such as Red Flag. The second form of the problem is that two-sided war gaming is not possible except on a limited basis. Isolated intercept exercises ranging from one interceptor vs one hostile (1 v 1) bump-heads through perhaps four interceptors vs four hostiles (4 v 4) are possible in most systems, but large-scale exercises provide essentially no interactive play. Except for IPS tracks (for example, T-4 tracks) which are interactive, large-scale exercises are largely predetermined and unfold without regard to the actions of the $C^2$ team.

The problem of low geopolitical relevance has a motivational and content-oriented impact on the effectiveness of simulation exercises. Students expressed boredom and disappointment with training scenarios based on prior conflicts (for example, the Korean conflict). Instructors also were concerned about the value of training $C^2$ teams to deal with yesterday's battles instead of tomorrow's. The students and instructors felt that it would be valuable to learn the names and relationship of landmarks, as well as the airspace and force coordination procedures, in a variety of world regions. This concern was expressed especially by AWACS instructors and team members because of the mobility and worldwide responsibilities of their system.

AWACS Simulation Exercise Program Packages (SEPPs) are intended to fill this need. SEPPs, which are families of related exercise problems, unfortunately are largely noninteractive and do not present a realistic threat in a currently relevant geopolitical context.

Important training support functions are outlined in Chapter 2. Many of the instructors we interviewed expressed frustration over the lack of support provided by existing simulators. Many of their performance monitoring, assessment, and feedback functions could probably, in their opinion, be automated, thus freeing them to perform more productive duties. Instructors would also value the capability for modifying the details of the models and data base comprising exercise driver scenarios.

The sense of frustration felt by instructors and students was compounded by the feeling that communication channels and procedures do not exist

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for translating their observations and recommendations into incremental improvements in existing training devices. This problem is discussed in more detail in Chapter 4.

## ASSESSMENT OF TEAM AND SYSTEM PERFORMANCE

The primary responsibility for assessing $C^2$ performance in terms of team readiness or system effectiveness rests with the personnel of the standardization/evaluation (stan/eval) program. Team readiness is difficult to assess; the use of subjective measurement methods is complicated by factors relating to the conditions under which performance is assessed. The attempt to be objective in measuring system effectiveness is subject to influences unrelated to effectiveness, for example, mission difficulty or political constraints.

### Standardization/Evaluation Program

The purpose of the $C^2$ stan/eval program is to ensure that the performance of individuals and teams meets the standards established by HQ directives. Stan/eval personnel are selected through a nomination/approval process involving peer judgment of the individual's performance competency; they receive no special training to perform their duties. Their own performance is evaluated by stan/eval personnel from higher-level units or HQ.

The stan/eval program within each unit is organized as a mini-version of the operational sections of the system. That is, one individual is assigned as the responsible person for all supervisors and technicians within a section.

The stan/eval program consists of several different types of individual evaluation. Phase and initial evaluations are associated with approval for OR status. Annual and spot evaluations monitor skills maintenance. Upgrade evaluations are the basis for advancement into a higher skill category. All individual evaluations take place in the context of a simulated mission. The rating scale method is used.

Team evaluation is carried out four times a year. The vehicle for team evaluation is a simulated or live (as available) system exercise which may vary in scope. The evaluation is oriented towards the supervision and performance of a section, for example, surveillance, weapons, etc. The method is observation and the evaluation is documented in an after-action report (AAR) describing the positive and negative aspects of team performance. Feedback to the team is delivered during a mission/exercise debriefing and through the AAR.

The AAR provides a data base (organizational memory) for determining the objectives of subsequent exercises. Furthermore, the AAR must be responded to with recommendations for corrective action. It was our observation that the AAR is not used to its fullest advantage as a mechanism for enhancing organizational memory with regard to team and system effectiveness.

Difficulties in Assessing Team Readiness

The assessment of team readiness is complicated by three factors. First, the lack of standardization of conditions under which performance is evaluated is a problem. The evaluation may take place in a live or

simulated environment, and difficulty may vary widely. Second, the shortage of live sorties for evaluation (as well as training) means that the conditions of battle are only marginally approximated. Third, in a system like AWACS without hard crews, the team evaluation applies on a one-time basis only. There is thus no opportunity for the particular set of individuals to learn from their errors made in working cooperatively.

## Measures of System Effectiveness

Headquarters personnel have responsibilities which prevent them from getting involved in the details of team assessment. They monitor individual progress in terms of any failures to meet training requirements. However, there is a recognition of the fact that even if all members of a team are rated as operationally ready, it doesn't follow that the system will be effective in meeting mission objectives. In order to get a grasp of this aspect of assessment, mission success is evaluated.

The most obvious measure of success of $TAC^2$ systems is the percentage of hostile tracks identified and targets intercepted/killed. This measure has been used in SAGE as an index of the system's state of readiness. One of our respondents pointed out a shortcoming of this measure. Namely, it doesen't take into account the difficulty of the conditions under which it was obtained. Such factors as the number, density, and speed of tracks differ from one exercise to another. Thus, a figure of 95% targets intercepted is misleading without some indication of the exercise difficulty. A more valid measure could be obtained by weighting the score by a difficulty factor, much the same as is done in Olympic diving. The final score for individuals or teams depends upon the difficulty of the dive (exercise) and a rating of how well it was performed.

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Another method of assessing system effectiveness is built into large-scale exercises. Repeated problems in attaining mission objectives, for example, linking AWACS to Navy units via TADL-A, come to the attention of HQ personnel. Such problems become the focus of exercise planning conferences. Thus, the determination of exercise objectives can be sensitive to issues of system effectiveness.

MANAGEMENT ISSUES

Training program success, in addition to being determined by methods of training and performance assessment, is heavily influenced by management philosophy and policies. Management issues are present on two different levels. At a general level there are considerations related to $TAC^2$ career fields; the central issues concern recruiting and selection, promotion opportunities, job satisfaction, and the cumulative impact of all of these on motivation. There are also factors which impact specific training programs. These include 1) manager expertise and knowledge, and 2) management of training for new systems.

## Career Field Issues

$TAC^2$ career fields are not among the more glamorous or desirable fields in the Air Force. At the same time there is currently a critical need for personnel to become weapons controllers and aerospace warning and control technicians. The career field's problems stem from two sources: 1) lack of visibility, which makes it difficult to attract volunteers; 2) undesirable characteristics of the duty and promotion possibilities, which make it difficult to retain quality people.

The numbers of controllers needed exceed the supply of available people and the manning of AWACS, making a heavy drain on the current complement of controllers. There are not entry qualificiations for this field at present. Imposing selection criteria would reduce still further the available manpower pool.

The stereotypical job in the Air Force is that of flying airplanes, which is unfortunate because there are many other technical specialties and careers. Of the many necessary support functions, $TAC^2$ is probably the least well understood by recruiters, enlistees, and officer candidates alike, if they are even aware of them. Consequently, the individuals who are selected for $TAC^2$ career fields are infrequently volunteers and often have no idea what the jobs involve. Our instructor respondents reported that many student controllers arrive at Tyndall without having had any orientation to the career field. Despite this and any disillusionment it may cause, the motivation of students in initial training is usually high, although student weapons controllers may be lacking in certain prerequisite skill, for example, mathematical or communication (English), because of the absence of selection criteria.

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Given the critical need for $C^2$ personnel, one might expect that there would be ample promotion opportunities in the career fields. Unfortunately for the weapons controller, this is not the case. The number of 17xx personnel who may hold rank of LTC and above is actually quite limited. Pilots do tend to dominate in this aspect of career advancement. Pilots receive flight pay but AWACS personnel, who spend the same amount of time in flight as their pilots, do not receive flight pay. Our 17xx respondents were very aware of this and were outspoken about the dissatisfaction that it causes.

$TAC^2$ duty possesses several characteristics which make it undesirable according to our respondents. Periodically, duty assignments involve serving in remote locations, for example, the Aleutian Islands. Remotes, as these assignments are called, pose a hardship, especially for married personnel. Although remotes are viewed negatively, they would not cause significant problems in and of themselves. Command and control jobs in TAC in peacetime lack relevance. This is especially true for TACS and AWACS, which have no peacetime, that is, non-tactical, mission. Live training exercises are too infrequent to have a positive influence. The primary mission of SAGE/JSS has shifted from air defense to air sovereignty, so that the day-to-day activity has meaning. However, as our respondents reported, even in this context the jobs of surveillance personnel are tedious and the weapons section may go days waiting for a low-frequency event, that is, a track with unknown identity.

The lack of promotion opportunities and the negative features of $TAC^2$ duty have combined to significantly demotivate $TAC^2$ personnel. This has led to a low retention rate in these critical career fields.

## Program-Specific Issues

Training program managers in TAC have responsibilities which their previous experience may not fully qualify them to discharge. Managers are selected not according to demonstrated ability to control the conduct of training, but rather according to rank and general management ability. Our respondents indicated that the biggest problem was a lack of awareness of the overall $TAC^2$ training pipeline and the skill levels trained/achieved in each course. It was difficult to assess the magnitude of this problem, but because it surfaced at TAC HQ its importance should not be overlooked.

A second issue concerns the training implemented for newly-acquired systems. AWACS training problems are traceable to a management philosophy that places a premium on successful testing during acquisition. To achieve this success, training decisions are made which in the long run can be detrimental. Two examples illustrate the problem.

As noted previously, personnel for the JSS will be crosstrained from SAGE. Consequently, the training program which is defined and developed is not designed to train inexperienced personnel. There is no problem while the SAGE experienced manpower pool lasts. However, as soon as personnel turnover requires training of inexperienced controllers and technicians, a tremendous strain could be placed upon the training managers at JSS regional sites. At that point, either the ATC and TAC APQ fundamentals courses must be modified, or the operations (cross) training program will have to be expanded to include a front-end initial transition course. In this instance, it is likely that the AWCT and APQ courses will have already

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been modified to prepare controllers and technicians for JSS duty. The JSS ROCC Systems Support Facility at Tyndall is planned for use as a training device.

Despite the potential problem in transitioning the JSS program from cross-training to replacement training, there is a plan for accomplishing the transition smoothly. The reason for discussing this issue is that in a historical perspective this is a possible explanation for how the AWACS training program got into trouble. To ensure successful development and operational tests when the system was being acquired, the training was oriented toward experienced individuals. However, there was no existing manpower pool to draw on since AWACS was not replacing an existing system. Thus, when the system was deployed there was a training vacuum. The result has been implementation problems in the AWACS training program. The ongoing course definition and development would have been accomplished much earlier if the new system "crosstraining philosophy" had not dominated the training planning.

CHAPTER IV

STATUS OF AFC$^2$T$^2$ PROGRAMS:
EVALUATION AND MODIFICATION

OVERVIEW

Comprehensive training programs have procedures for evaluating the
effectiveness of training and modifying training in response to discrepancies.
Such procedures can extend to the evaluation and modification of training
devices. In this chapter the procedures for evaluating and modifying C$^2$
training programs are described, analyzed, and themselves evaluated.
The discussion is organized around three topics:

- Program evaluation procedures

- Program modific: tion procedures

- Simulation/simulator evaluation and modification

A preview of the findings follows.

Evaluation is a key step in the ISD process. It may be based on the
trainees' attainment of training objectives (internal evaluation) or on job
performance of recent graduates (external evaluation). In C$^2$ training
programs both types of evaluation take place. Internal evaluation tends to
be formal, especially in initial training programs, but is hampered by
incomplete specification of performance standards. The standardization/
evaluation (stan/eval) procedures which are applied in operations training
programs are a mixture of formal and informal. The procedures are

described and on balance the stan/eval program is judged a strength; but several areas for improvement are noted. External evaluation is very informal if it occurs at all and is hampered by a lack of objective conditions and criteria for job performance, which leads to misunderstandings between ATC and TAC personnel. An example arises out of the nature of the intercepts an air weapons controller is trained on in the Fundamentals Course. These simulated intercepts are "canned," that is, predictable and specifiable. Students can control successfully under these conditions, but initial transistion training, for example, at the 607 TCTS, is based on enetering students being able to control under less predictable and specifiable conditions. Evaluation of large-scale exercise programs is based on professional judgment and some of the potential problems with this are discussed.

Programs may be modified using ISD procedures as long as the entry point, for example, job task listing or development of training objectives, of the process is specified. It is difficult to apply ISD to modification if either the program was not developed using the ISD process, or the process was poorly documented. It is this latter problem which characterizes the status of $C^2$ training program modification. This problem and non-training factors, such as resource shortages which influence program modification, are discussed in the second section.

There exists no systematic procedure for identifying simulator deficiencies and potential solutions. $AFC^2$ simulator design does not lend itself readily to modification for improving capabilities. In general, the simulators used for $AFC^2T^2$ are excellent simulators, but marginal training devices.

## PROGRAM EVALUATION PROCEDURES

There is no comprehensive, formal set of program evaluation procedures used for both internal and external evaluation; each program is evaluated by a combination of different procedures. The primary procedures in use are 1) application of ISD, 2) assessment of student skill level, 3) achievement of training requirements, 4) professional judgment of the state of personnel readiness, and 5) student and field questionnaires. Attrition rate, which might be a useful measure of training effectiveness, is not very useful in the $TAC^2$ environment because of lack of selection criteria for weapons controllers and because the rate is more a function of management policy and pipeline needs than student success. In the following subsections each evaluation procedure is described and its strengths and weaknesses are discussed.

### Application of ISD

Although ISD is a process typically associated with training development, the Air Force has applied ISD to existing programs in order to determine if they provide economical, effective instruction. When applied with this purpose, ISD should begin with an analysis of job tasks. Our survey indicated that this approach to program evaluation has had mixed success.

For example, the Air Weapons Controller Fundamentals course was the subject of an ISD analysis in 1978. The survey results indicated that this analysis, rather than serving as the basis for a critical comparison of controller job skills with course training objectives, was used merely to justify (validate) the then ongoing training. On the other hand, the ISD

analysis performed by the 4444th TACS/OTD (Office of Training Development) has provided a meaningful evaluation of the TSQ-91 AWC initial transition training program. The analysis objectively defined AWC job tasks and determined training reqûirements by comparing entry-level skills with desired on-the-job skills. An interesting byproduct of this analysis was the discovery that the entry-level skills of ATC Fundamental course graduates were not in line with 607th TCTS expectations. The TACS/OTD analysis concluded that 1) student proficiency on 1 v 1 intercepts was not sufficient for transfer to the TSQ-91 environment, and 2) students were unprepared to perform under a wide variety of circumstances, because Fundamentals course practice conditions were arranged so that intercept setup and positioning were predetermined.

If ISD is used to evaluate a training program, it should not be carried out by those with a vested interest interest in the outcome. Otherwise, the results may not be objective. Unfortunately, because ISD requires subject matter experts (SMEs), it is difficult to find qualified individuals who are not associated with the program under scrutiny and who will not be directly affected by the results. It is therefore a positive sign to find an independent group, the 4444th TACS/OTD, whose sole mission is training development for elements of the Tactical Air Control System. The TACS/OTD serves as a model for overcoming the often inherent bias when ISD is used to evaluate a training program; this is an $AFC^2T^2$ strength.

## Assessment of Student/Team Skills

Within the ISD framework, proficiency assessment is the standard means of evaluating program success. If students meet course performance

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standards and teams are judged combat-ready, then it is commonly inferred that training has been successful. Of course, this inference assumes that performance standards and readiness criteria have been adequately defined; this is not always the case. Course performance standards are not always objectively defined and $T^2$ requirements and standards are not formally developed. Furthermore, there is a tendency for training exercises to become ends in themselves and their relationship to job requirements is rarely well-defined.

The final responsibility for assessing proficiency in initial and operations training programs rests with stan/eval personnel. As discussed in Chapter II, objective written tests and oral exams are used to assess knowledge proficiency and positional performance is used to assess skill proficiency. Standards are rather straightforward in the area of knowledge, for example, attain 90% correct, but not so in skills. In particular, the criteria for speed and accuracy of positional performance are rarely specified concretely. For example, our survey failed to discover any documented criteria for judging the positioning accuracy of an intercept event. Such standards are incorporated informally into positional evaluation by stan/eval personnel based upon their expert judgment. The expert judgment is a strength, but the informality is a weakness.

The proficiency levels which are defined in conjunction with a CTS (course training standard) are, therefore, imprecise and open to interpretation. This makes it difficult to evaluate program success from the standpoint of performance on the job. That is, TAC and ATC experts may disagree on whether a student controller has achieved, for example, level 2 skill proficiency, because of this imprecision; or if they do agree, they may

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discover later that they were interpreting the description of proficiency differently. Until a greater effort is made to externalize and document performance standards, such disagreements will continue to occur (see previous subsection). The result is that in the case of skills requiring technique, proficiency assessment is of limited validity as a procedure for evaluating a training program.

The criteria used to assess team readiness in system or large-scale exercises (informal $T^2$ programs) are unspecified and the assessment methods are relatively informal. The stan/eval personnel have no documented guidelines for assessing team proficiency. The most formal aspect of the evaluation procedure is the generation of an after-action report (AAR). These reports, however, are used on an exercise-to-exercise basis rather than serving as a storehouse of exercise program evaluation data. Thus, the assessment of team readiness as it is currently carried out does not provide a valid or efficient procedure for evaluating the informal $T^2$ programs.

On balance, the stan/eval program as applied to individual proficiency is a strength without which quality control would be difficult. Major discrepancies are prevented, but finer discriminations are impossible. The lack of objective, behavior-referenced criteria for assessing individual team-oriented skills and team performance limits the evaluative power of the stan/eval effort.

## Achievement of Training Requirements

Another method of program evaluation consists of determining whether training requirements have been achieved. As discussed in Chapter II, training requirements for operations training programs are defined in terms of minimum number of events/exercises or hours per topic or activity. The attainment of minimum training experiences is clearly important and the measures produced are convenient statistics for HQ personnel. However, it has not been established as to whether these amounts of events/activities are in a training-effective quantity. They tend to be limited in number and type by resource constraints and their characteristics are not fully responsive to training objectives for job performance require-ments. Although the minimums have been established and endorsed by experienced personnel, there is a critical lack of empirical data regarding the meaning of attaining the requirements in terms of readiness and skills maintenance. Therefore, the attainment of training requirements as presently defined does not constitute a necessarily valid procedure for evaluating operations training programs.

## Professional Judgment of Readiness

The key element of the stan/eval program is professional judgment. There are also less formal ways in which professional judgment plays a role in training program evaluation. This is especially evident in large-scale exercises, which are based on developing the ability in personnel/systems to meet potential threats, for example, tactics of a possible adversary, and in informal feedback to schools from the field.

Professional judgment is the sole basis for evaluating whether exercises like Red or Blue Flag provide sufficient training to achieve and maintain combat readiness. The evaluation procedure is fairly unstructured and decentralized. Any individual may offer a critique and by persuasion develop a consensus that training must be modified or developed.

This procedure is essential to exercise program evaluation, but the fact that it is informal means that it is based on the appearance of a vocal advocate. That is, some individual must feel strongly enough about the problems to go on record. This situation is subject to some weaknesses. For one thing, if the advocate is transferred without developing a consensus that improvement is necessary, the motivation for modification can disappear. For another, without combat experience professional judgment becomes second-hand or speculation based on intelligence. Finally, because the procedure is informal, the evaluation rationale and decision-process may not be (well) documented.

Informal feedback from the field to the schools works in the same fashion and is subject to the same weaknesses. However, there is a questionnaire technique in use which attempts to close the loop between the operational and institutional settings.

## Student and Field Questionnaires

Questionnaires are employed formally in program evaluation throughout the $AFC^2T^2$ programs surveys for two purposes. First, the students are given an opportunity to critique the course they have just completed. Second, the opinions of operations training program personnel are surveyed by ATC and TAC institutional personnel.

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Institutional training program managers are as responsive to this information as they can be within the limits of policy and available resources. But several factors work against the utility and validity of the information produced via the questionnaires.

Students are not always in a position to judge whether they have been trained effectively or to a sufficient level of proficiency. Their judgments can only be based on whether the training was sufficient for them to pass the knowledge and skill proficiency tests. Because these tests lack formal assessment of team-oriented skills the information from students is of limited value. Also, students tend to be less outspoken and critical for fear of possible adverse effects on their careers. These factors, however, do not have an especially noticeable negative impact. The solicitation of student opinions is a valuable management tool which prevents major discrepancies in training administration.

Feedback from the field regarding the qualifications and proficiency of the institution graduates is useful and necessary to obtain. However, in the weapons controller career field there has developed a "rift" in understanding between the field and school personnel because of the way in which "controlling" is taught.

In the school environment standardization is paramount. Each operational location has local operating procedures and requirements, some of which represent special cases and therefore deviate from standard procedures taught in the school. Furthermore, because the task of controlling aircraft cannot be fully proceduralized, individual biases and methods come into play. Different units may come to represent different schools of thought

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on controlling techniques based upon different experiences. The institutional setting and the field setting exemplify different schools of thought in this sense. When the field questionnaires comment that the school doesn't train the proper technique or criticizes the fact that the operating procedures taught do not apply to their location, the school is caught in a bind. They cannot be responsive to these demands because they must turn out a standard or universally-assignable product. The net result is that all feedback from the field is taken with a "grain of salt." The problem is that institutional training programs can wind up operating in an open-loop situation and take on a separate existence.

## PROGRAM MODIFICATION PROCEDURES

Training program modification is necessary when evaluation procedures provide evidence of a training shortfall, or when systems or missions are modified. The survey results indicated that application of ISD is the primary procedure used to revise training programs; systematic procedures are not always used although this is highly desirable. Occasionally, training programs are modified as a result of resource limitations, which may include changes in student qualifications, or changing management policy.

### Application of ISD

Where ISD is used as a tool for $C^2$ training program revision, it is subject to the same limitations that apply to its use for definition and development. These limitations fall into two categories: ISD structure and how it is applied.

Foremost among the structural limitations is that the analysis does not adequately address the definition of training requirements for team-oriented, that is, cognitive, skills. Furthermore, it does not provide for the design of $T^2$ exercises of simulated combat missions in terms of establishing training objectives and exercise characteristics as related to job performance requirements. Considering that these two problems are, according to the present evaluation, in need of immediate attention, the ISD procedure itself must be augmented, modified or applied in novel ways before corrective action can be taken.

In the method of application category, perhaps the biggest limitation concerns inadequate documentation. Any training program modification is much easier if the original ISD analysis has been thoroughly documented. As noted earlier, this is rarely the case in $C^2$ training development. Without such documentation, modification may require that earlier thinking be resurrected, and if the personnel who did the original development are gone, the process becomes time-consuming and is wasteful. An audit trail of training definition and development decisions is essential for efficient program modification.

## Non-Training Factors

$C^2$ training programs are occasionally modified as a result of a shortage of funds or manpower, or a change in management policy. For example, the ATC Fundamentals Course included system training exercises until 1975. They were discontinued as a result of budget cuts and the end of the Vietnam war. At the same time, the course was shortened and the training standard to be attained was lowered from control of two interceptors

against one hostile aircraft (2 v 1) to one interceptor versus one hostile aircraft (1 v 1). The consequence of this change of standard is that the operations training programs or initial transition training either must change their standards or increase the time devoted to upgrade.

Another example is the 607 TCTS, where the TSQ-91 initial transition course is taught. Until recently, the 607th was an operational unit (CRC) with a full complement of personnel; during that period students were trained in team skills in system exercises. When the unit's status changed from operational to training as a result of manpower cuts, this team skill training could no longer be carried out.

Finally, an example of the influence of management policy on program modification comes from the ATC Fundamentals Course. Recently, ATC policy fixing the length of a training day at eight hours has been enforced. Because the training is group lock-step, some students upon completing a lesson cannot continue until all other students have reached the same point. Previously, these more advanced students were free to use the additional time as they wished. Now they must be present for eight hours and the instructors have had to generate academic training (which they feel is meaningless) to fill the time. Our respondents indicated that if the eight-hour day was to be strictly adhered to, the course should be self-paced so that better use could be made of the time.

SIMULATION/SIMULATOR EVALUATION AND MODIFICATION

Evaluation is the step that is designed to close the loop in the training device development cycle. A training device is fielded upon completion of the

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definition and development process. While the system is in actual use, a formal procedure should be followed to record, consolidate, and analyze student and instructor comments about design deficiencies and potential solutions. At periodic intervals, the feedback should result in incremental improvements to the system. This process, unfortunately, rarely occurs.

The T-2 and T-4 systems have been in use for many years, and their major deficiencies are by now well-known among users. The capabilities and algorithms are locked so tightly within the electronics of the systems, however, that a major effort would have been required to effect significant improvements. Therefore, the strategy that was adopted was to use the system as effectively as possible until it could be replaced entirely. The System Training Exercise Module (STEM) is the intended replacement. Until the STEM is fielded, the training programs will have to use unimproved T-2 and T-4 systems.

The greater use of software-controlled $C^2$ systems and training simulators suggests that improvements may be easier to implement than was the case with older electronic systems. The AWACS simulator demonstrates that this prediction is not necessarily valid, however. The AWACS simulator software is under the same rigid configuration management system as is the operational software. The extremely conservative configuration control maintained over the operational airborne software is appropriate because of the strict safety and reliability standards that must be met, but it causes serious difficulties for the training system. One problem is that, except for IPS consoles, the simulator includes essentially no training support features. Other problems are that the SEPPs provide inadequate training and are difficult to modify, the surveillance team

and command staff cannot be sufficiently exercised, support personnel cannot be included in team exercises, and relevant variables in the tactical environment (ECM/ECCM) cannot be exercised well. These problems became apparent to users shortly after the first AWACS simulator was delivered. Feedback was sent to the designers, but it had no significant impact. The second AWACS simulator, delivered in 1980, is essentially the same as the first. The Air Force now owns two expensive devices (over $10 million each) that are exceptional simulators but marginal training devices.

CHAPTER V

CONCLUSIONS AND IDENTIFICATION OF HIGH-PAYOFF ISSUES

Previous chapters of this volume have characterized the status of $C^2$ training programs. The methods used to define, develop, implement, and evaluate $C^2$ training programs have be·· ·scribed, analyzed, and evaluated. The evaluation permitted ide.. .fication of $AFC^2T^2$ strengths and weaknesses.

The purpose of the present chapter is to consolidate the weaknesses into issue areas and discuss them. The issues are prioritized according to the impact their resolution is anticipated to have on increased training effectiveness or reduced training cost. Subsequent volumes will develop plans and recommendations for addressing the issues through 1) a program of training research and development, 2) application of current available training technology, and 3) the development of a simulation facility for research.

Many of the issue areas identified will be familiar to those readers acquainted with the $T^2$ research literature. Progress in the development of an accepted team performance theory has been slow. If a mature scientific field is characterized by having a shared paradigm[1] (Reference 19) then the science of team performance can be said to be pre-paradigmatic.

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[1]"Universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners" (Reference 19).

It is for this reason that a number of the issues characterize the status of $T^2$, whether in the tactical $C^2$ domain or not. Paramount among these general issues is the absence of a generally-accepted conceptual framework for the definition and development of $T^2$. The result is that there are no formal $T^2$ programs for $C^2$ teams and systems and the consequence of this is that team-oriented skills are trained in an unsystematic manner, at best.

In order to focus the conclusions and a discussion of the issues, the areas of concern have been categorized according to whether they involve $T^2$ definition and development, implementation, program evaluation and modification, or personnel policy and resource constraints. Table 12 presents the issues and problem areas. Within each category, the issues are listed in descending order of resolution priority. The categories themselves are also in priority order with the exception of the constraints. These are presented last as they are, in general, not addressable through research and development, and in most instances are part of the fabric of $AFC^2T^2$, which must be taken into account when proposing approaches to resolving any issue.

Issues of training program definition and development have the highest priority, because their resolution is fundamental to extended progress in establishing formal $T^2$ programs and in improving $T^2$ efficiency and effectiveness. On the other hand, the solution of more specific problems could have a high payoff in terms of enhancing current operations. Also, a higher probability of success can be expected on narrower, presumably better-defined problems. The discussion of each issue which follows includes a summary of the problem(s), the rationale for its priority placement, and the consequences of not resolving it.

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TABLE 12. AFC$^2$T$^2$ ISSUES AND PROBLEM AREAS

| Definition and Development | Implementation (concluded) |
|---|---|
| Lack of a definitive framework for identifying and analyzing team aspects of operational systems and defining team-oriented task structure. | Lack of training for personnel who simulate interceptor pilots during initial and initial transition training. |
| Lack of objective criteria and standards for evaluating team-oriented skills, individual and team readiness, and system effectiveness. | Lack of AWACS-oriented block of instruction in Air Weapons Controller Fundamentals or APQ Courses. |
| Lack of analytic techniques and empirical data for determining institutional and operational T$^2$ requirements and objectives. | Lack of instruction for supervisors, battle staff personnel, and decision-makers.<br><br>**Program Evaluation and Modification** |
| Lack of comprehensive, systematic procedures for defining training objectives for simulated combat missions. | Lack of valid evaluative measures for initial and initial transition training programs. |
| Inadequate planning and analytic techniques for defining T$^2$ simulation/simulator fidelity and functional requirements. | Incomplete use of existing evaluative data for system exercises/simulated combat missions.<br><br>**Personnel Policy and Resource Constraints** |
| Failure to define and develop formal training for C$^2$ system supervisors.<br><br>**Implementation** | Low retention rate of experienced C$^2$ system personnel. |
| Deficient simulator capabilities including a lack of facilities for combined systems training. | Shortage of live flying intercept events and BCM activities for T$^2$. |
| Mismatch between entry-level requirements and Air Weapons Controller Fundamentals Course syllabus. | Inadequate instructor training and evaluation in operations training program. |
| Lack of empirical data regarding the optimal instructional methods and sequencing for subteam, team, and superteam skill training. | Difficulties posed in training and evaluating "soft" as opposed to "hard" teams. |
| | Inadequate understanding of C$^2$ training pipeline on the part of C$^2$ training program managers. |

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$T^2$ DEFINITION AND DEVELOPMENT

Six issues were identified as important in the category of training program definition and development. These issues have the highest priority relative to the other training program areas because they are at the root of problems and weaknesses found throughout $T^2$ programs. The issues are ordered in descending priority.

## Lack of a Definitive Framework for Identifying and Analyzing Team Aspects of Operational Systems and Defining Team-Oriented Task Structure

This is a fundamental issue underlying all other problems and weaknesses in $C^2T^2$. If this issue is not resolved there can be no progress except of a piecemeal sort on the narrowest remaining issues; there will continue to be lack of emphasis on $T^2$ issues during $C^2$ system acquisition and the $T^2$ that is developed will be insufficient to accomplish the training mission effectively.

A solution to this issue entails the development of a conceptual framework embracing both a taxonomy of team-oriented skills and a methodology for considering team characteristics in $C^2$ system design. It is only within such a framework that the most critical deficiency in $T^2$, namely, a lack of specific $T^2$ objectives (Reference 20), can be resolved.

The characteristics which a $T^2$ conceptual framework should possess are as follows:

1. A classificatory scheme of types of $C^2$ teams according to structure, functions, missions, etc.

2. An identification of the dimensions of the process of team performance and variables associated with task output.

3. A taxonomy of team-oriented skills along with a task analytic procedure which forces attention to cognitive skills necessary in cooperation, coordination, and communication.

The characteristics of a $C^2$ system design framework should include:

1. Guidelines for determining mission/task functions allocatable to machines, individuals, and teams.

2. Guidelines for the design of $C^2$ systems which efficiently support the functional allocation of tasks.

3. Information predictive of the effects of task or position automation in $C^2$ systems.

It is our opinion that the reason for lack of progress in the area of team training is the failure to deal comprehensively and consensually with this fundamental issue. If our contention that team performance theory is in a pre-paradigmatic state is correct, the approach to resolving this issue should consist primarily of obtaining descriptive data from extensive observations of $C^2$ team performance. The observations should be carried out with a tentative taxonomy of team skills/behaviors developed in accordance with the cognitive orientation proposed in Chapter III. The data base so acquired will provide a clear picture of the team performance phenomena which must be explained. The initial goals of this effort would be a conceptual framework for classifying $C^2$ teams and a model of $C^2$ team performance.

## Lack of Objective Criteria and Standards for Evaluating Team-Oriented Skills, Individual and Team Readiness, and $C^2$ System Effectiveness

This issue is quite complex since it covers several different problems of performance evaluation. There exist no measurement tools to 1) assess individual team-oriented skills and relate their level to some standard (of readiness), 2) assess team readiness, or 3) evaluate $C^2$ system effectiveness. Each of these problems must be resolved, possibly with different approaches.

Resolving the problem of measuring an individual's team-oriented skill proficiency requires development of a valid task taxonomy and this, of course, is part of the resolution of issue number 1. A valid taxonomy, however, must be supplemented with performance standards which reflect levels of proficiency in an orderly manner. Such standards can be described a priori in established situations where the responsibilities and operating procedures are defined. But the absence of standards is part of the definition of emergent situations; there may be more than one acceptable solution to a problem. Another way of looking at this is that standards apply well to performance which is prescriptive or algorithmic when particular events and outputs can be expected, but become obscure if performance is descriptive or heuristic when the process of performance is unpredictable. This, in fact, is the primary reason for the importance in individual evaluation of observers who are experts in the (standards of the) performance under observation. What is needed is a better articulation of the standards of individual team-oriented skills, one which takes into account the emergent nature of tactical situations.

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Observation of the process of performance should be at the heart of evaluating team readiness and system effectiveness. Readiness cannot be judged solely by concrete measures of number of exercises or activities engaged in per-unit time, or percent of targets detected/intercepted. Although such information is convenient for obtaining summary statistics for use by higher headquarters, it overlooks critical factors such as the quality or difficulty of the experiences or the process of achieving mission objectives. Such process information is captured to some degree in AARs, but as noted below these are not used to full advantage. Part of the reason they are not used, especially for program evaluation and by higher headquarters, is because of their narrative format.

One approach to resolving this performance evaluation problem would be through the application of multi-attribute utility theory (MAUT). MAUT provides a structure for analyzing a decision situation into independent evaluative dimensions and specifying the dimensional attributes character- istic of useful outcomes or alternatives. The analysis of the decision situation, that is, the expert's basis for judging readiness/effectiveness, should provide an identification of the dimensions of the process of team performance. Note that this identification is a characteristic which must be possessed by the framework needed for the resolution of issue #1.

The suggested approaches to resolving the performance evaluation problems focus on increasing the structure and orderliness, thereby the validity, of current techniques. The Army has been proceeding along these same lines with the ARTEP (Army Training and Evaluation Program).

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The subject matter expert is still the only valid source of evaluative information in $C^2T^2$. The primary goal of measurement development should be to improve the expert's tools.

Resolution of these problems is a prerequisite to conducting useful $T^2$ research. Also, without resolution it is difficult to ensure standards for quality control in training and operational readiness.

## Lack of Analytic Techniques and Empirical Data for Determining Institutional and Operational $T^2$ Requirements and Objectives

The successful resolution of this issue depends upon the resolution of issue #1. Without a task taxonomy which forces attention to consideration of team-oriented tasks producing a valid, complete task list, training requirements and objectives cannot be defined. This is true whether the $C^2$ syste n in question is in development or deployed, and whether the training is institutional or operational. If this issue is not resolved, then training cannot be improved in a consistent, verifiable manner.

The approach to this problem should be through an extension or augmentation of the Interservice, or other applicable, ISD procedure. As the preeminent systems approach for defining and developing training, ISD must be used as the vehicle for such an effort. It is our opinion that the problem is tractable within the ISD framework, given some revisions.

A revised ISD procedure should address, among other things, problems within $C^2$ system acquisition. Training development for $C^2$ systems which are being jointly acquired is hampered by sometimes conflicting approaches

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to and constraints on training. Training developed for new $C^2$ systems is too heavily weighted toward experienced individuals thus creating undue pressure on institutional and operational training units when the student pipeline begins to process inexperienced personnel. Finally, in general, appropriately derived techniques should allow training developers to address issues for systems which are unique or a clear departure from existing systems.

Although it is important to develop analytic techniques for establishing initial $C^2T^2$ knowledge and skill requirements, it is equally important to develop a data base regarding $C^2$ skills decay. This data will help define refresher training (skills maintenance) requirements.

The current practice of requiring a certain number of system exercises and events, or hours of activities per month, is of dubious validity. There are no empirical data establishing the relationship between performance frequency and combat readiness, and such data are needed. The relative priorities of this and the preceding issue are determined by the fact that measures of combat readiness are a prerequisite to skills maintenance research.

## Lack of Comprehensive, Systematic Procedures for Defining Training Objectives for Simulated Combat Missions

Simulated combat missions are used for exercising individual positional and team-oriented skills. This technique is necessary for achieving and maintaining combat readiness. Its major function is to expose $C^2$ teams to the quantity and quality of events which they might face in actual combat.

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The events themselves may be live or simulated, but the framework within which they occur is entirely fictional.

The specification of the quantity and quality of these events is the subject of this issue. These events must be responsive to the training objectives for a particular exercise. Working group conferences meet on a regular basis to plan exercises. However, the planning procedure is rather ad hoc and is usually constrained by limited resources. There is currently no set of guidelines for defining system exercise training objectives, especially when the system mission deals with emergent situations.

The definition of training objectives for system exercises is complicated by several factors. It requires the expertise in military tactics and doctrine plus additional knowledge which comes primarily with combat experience. Next it is necessary to create plausible, meaningful scenarios of events for missions which must capture the emergent nature of tactical combat. This requires a great deal of imagination and must be tied to the variability of mission requirements which characterize a worldwide military potential (TACS and AWACS). Furthermore, the quality and quantity of events must be tied to some index of training value, either in terms of team skills, mission task skills, or both.

The development of procedures or guidelines for defining training objectives for simulated combat missions should be approached from a framework emphasizing generic team skills and mission tasks. The single most important quality to achieve in event selection is variability. It is possible that the planning task demands exceed man's unaided information

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management abilities. One approach would, therefore, be to provide information management tools for planning exercises. Failure to resolve this issue means that system exercises will continue to provide unsystematic and, perhaps, insufficient training experiences.

## Inadequate Planning and Analytic Techniques for Defining $T^2$ Simulation Fidelity and Functional Requirements

This issue reflects the fact that the fidelity and capabilities of current simulations/simulators are more related to the level of technology available or acquisition resource limitations than to what might be required to support training. Resolution of this issue entails the development of a data base relating simulation characteristics, cost, and performance benefit. Failure to resolve this issue will undermine the critical and expanding role that simulation must play in $C^2T^2$.

Some of the specific existing problems indicative of this issue are discussed in the Implementation section of this chapter. In general, the approach to developing the requisite data base should be through empirical research conducted by using a facility with a high degree of functional flexibility. This facility should be capable of supporting research both in $T^2$ technology and simulation fidelity and capabilities. Most research issues will fall in neither category exclusively. For example, the use of voice recognition/ synthesis might be explored as a training technique for enhancing the training of team communication skills, perhaps to replace or augment intercept pilot simulators. However, the required simulation fidelity for voice applications is also a question for research.

## Failure to Define and Develop Formal Training
## for $C^2$ System Supervisors

This issue is to a large degree a matter of policy, not the consequence of
a lack of applicable training technology. Strong, competent leaders who
thoroughly understand their jobs are a prerequisite for superior team
performance. Yet in the Air Force system-specific training for supervisors/
managers is largely on the job (that is, during simulated mission) and thus
is informal, unsystematic, and consequently of limited value.

The training technology tools exist for rectifying this situation. Resolving
the issue is a matter of modifying policy and applying existing resources
to developing a structured, consistent training experience for $C^2$ system
supervisors. Such a training experience, for example, could consist of
observational learning based on role-playing of a prototypical supervisor
making difficult judgments.

Failure to resolve this issue means that $C^2$ systems will not have super-
vision and management which is standardized across the board.

## $T^2$ IMPLEMENTATION

## Deficient Simulator Capabilities

This issue is clearly related to the weaknesses in simulation/simulator
definition and development. It is treated separately because the problem
areas concern deficiencies in current training simulators. While it is
true that these deficiencies are symptoms of inadequacies in simulator
development, they are problem areas in their own right.

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Inadequate simulation of ECM and sensor management has presented chronic problems in all $C^2$ system simulations. The operational community acknowledges that this is a critical deficiency. However, even if the requirements for adequate ECM simulation were known, and studies should be undertaken to determine them, there would still remain the task of implementing them. The requirements might include simulating at some level of fidelity the output characteristics of interference, concurrent use of different types of EW/ECM, and counter-countermeasures. The task of writing the simulation software to meet these requirements would be extremely demanding and thus costly. But the cost resulting from a lack of preparedness to wage electronic warfare certainly would be even higher.

The lack of instructor (simulator operator) support capabilities in all $C^2$ trainers results from the use of operational equipment as training devices. It is less expensive to buy an additional copy of real hardware than to modify it to suit the training mission. But the long-term consequences of not incorporating such support may be more costly. The time available for training cannot be used as efficiently or effectively as it could be if the instructor were able to exercise direct control over the simulation and receive performance evaluation information (as opposed to data recording) automatically.

The types and degree of support capabilities will differ according to whether the application is institutional or operational training. For example, training controllers at independent (institutional) settings might require more interactive, real-time control by the instructor than training a team during a simulated combat mission (operational setting). In the latter

instance, simulation of an intelligent hostile force would be desirable. The determination of what kind of and how much instructor/simulator operator support to provide is a matter for research and development. There is no doubt that improved training effectiveness could be achieved through enhancement of the instructor's abilities to direct and control the trainee's experience and provide feedback about the trainee's performance.

Currently the AWACS simulator provides for simultaneous training of only a portion of the mission crew, primarily the surveillance and weapons control sections. There is no provision for team exercises which include the Airborne Radar Technician (ART), Communications Technician (CT), and Radio Operator (RO), nor for that matter, the aircrew. Coordination between the Air Surveillance Officer (ASO) and ART which is a key aspect of mission success is thus trained only in the aircraft. The Computer Display Maintenance Technician (CDMO) console is provided but only as necessary to initiate the system simulation; there is, for example, no fault simulation of the sort that would require coordination among various team members to diagnose (and repair), or to develop procedures for working around failures.

The result of incomplete positional simulation is that training time on the actual equipment in-flight is not used to its fullest advantage. Given the cost per live flying AWACS mission, this represents a waste of valuable resources. The drain of these resources will continue until the AWACS simulator is expanded to include additional crew positions and a fuller set of dynamic, interactive capabilities which promote the training of team-oriented skills.

A major deficiency in simulation is the lack of an adequate facility for system and superteam exercises in which $C^2$ personnel can be systematically trained and evaluated as a unit. There are some simulated exercises for units and two or more units but their major weakness is the emphasis on operations training; the training of the battle staff as integral members of the team is haphazard at best.

Blue Flag is the only available facility and it has many limitations. It is remotely located for most units; it is primarily manual in operation; the size and complexity of the scenario is correspondingly limited; and the collection and analysis of performance data is limited, subjective, and informal.

There is a need for a *well-designed* simulation facility for $C^2$ teams capable of exercising one or more systems of the size of a CRC, TACC, AWACS, and JSS as a total team. Adequate support in computers and personnel should be provided to operate the facility and to meet the requirements for training, performance evaluation, recordkeeping, and war gaming. One central facility could be provided, perhaps supplementing the Blue Flag facility. Another approach is to provide facilities in each unit, perhaps a lesser capability but more readily available as needed. The facilities in two or more units might be interconnected for larger exercises. A third option is to permit fielded units to tap into a large central facility by telephone lines and run local exercises using a scenario from the central facility.

The US Navy has developed two simulations which are centralized facilities: Naval War Gaming System (NWGS) and Tactical Advanced Combat Direction and Electronic Warfare (TACDEW). NWGS is a surface war game simulation to exercise the command staffs of a naval task force. The people are comparable to the battlestaff, TACC personnel, and command staff of a numbered air force. Two-sided, task force level games can be played for several days. TACDEW is a simulation of the combat information center for destroyers, cruisers, and aircraft carriers. It provides high-fidelity simulation of command operations for these surface ships.

These facilities can be used as models from which to investigate issues of developmental and operating costs, design, capacity, and use.

## Mismatch Between Entry-Level Requirements and Air Weapons Controller Fundamentals Course Syllabus

This issue must be considered in light of Air Force manpower resources and required manning levels. At present, the 17xx career field is critically undermanned and this situation is not likely to improve. Thus, although psychometric techniques are available for developing selection criteria, it is unclear whether such criteria could be applied to the available officer candidate population. As long as demand exceeds supply, the Air Force will not be able to be selective. The mismatch between what is taught and what is required, given the qualifications of the students, will continue to exist until corrective action is taken.

An approach to resolving this inability to be selective for the AWC career field is to provide supplemental training in mathematical, spatial reasoning, and English (communication) skills at the AWC Fundamentals course. These are the three areas which our respondents indicated were characteristic weaknesses of AWC Fundamentals students or which differentiate between good and poor controllers. Failure to resolve this issue places a burden on all subsequent units in the AWC training pipeline and has obvious consesequences for the quality of personnel in the AWC career field.

## Lack of Empirical Data Regarding the Optimal Instructional Methods and Sequencing for Subteam, Team, and Superteam Training

A systematic training methodology for $T^2$ does not exist. Systematic approaches to training presume a building-block approach in which components of knowledge and skill are integrated to provide behavioral capabilities that are needed on the job. The course of training is a progression through intermediate behavioral objectives that increasingly approximate terminal performance objectives. This systematic shaping, however, does not occur in $T^2$. There are two reasons for this. First, team knowledge and skill objectives are defined only in broad, general terms. The objectives are not analytic enough to support sequencing nor selecting particular training methods which might be superior to others. Second, existing training methods might not support the needs. In fact, there is a need for data regarding the success of various methods in $T^2$.

The resolution of this issue is tied directly to the fundamental issue of definition and development, as discussed above. A task taxonomy suited to analyzing team-oriented training requirements and objectives, however,

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does not resolve the present issue. Rather, in conjunction with valid performance measures, it provides a tool for gathering data regarding the effectiveness of various training methods in meeting the objectives. The consequence of not acquiring the data base is that $T^2$ will continue to be unsystematic. This lack of structure and focus undoubtedly is reflected in inefficient use of existing, limited resources for training. Methods suitable for training intermediate behavioral objectives will ensure that personnel subsequently trained in system exercises of varying levels of complexity will be ready to gain full benefit from the experience. The type and degree of individual pretraining in team-oriented skills to incorporate in intermediate objectives must be based on empirical data. The same holds true for the use of hybrid simulation training techniques, where the actions of some team members are modeled and the trainee's status is that of a man in the loop.

## Lack of Training for Support Personnel Who Simulate Intercepter Pilots During Initial and Initial Transition Training

This issue is prominent in initial and initial transition training programs, specifically the AWC Fundamentals, APQ, and TACS 407L courses. The individuals who simulate intercepter pilots (interceptor pilot simulators-- IPPs) receive no training beyond orientation to the equipment and radio vocabulary, pertinent to the task they perform. As a result, the training situation for AWCs is suboptimal.

A related problem is that during live flying in these same courses, the
pilots are usually students themselves. Because their skills are not
necessarily sharp, the training experience for both parties can leave
much to be desired. For example, the student pilot may not respond
correctly or as quickly as an experienced pilot to controller instructions.
Student AWCs may learn to compensate for these errors and may thus
learn techniques inappropriate to communicating with experienced pilots.

In either of these two circumstances, under-trained IPSs or controlling
student pilots, the problem can be rectified with current training technology.
A training course could certainly be developed for IPSs. This issue
properly falls, however, into the policy area and as such is not directly a
candidate for training research.

On the other hand, this problem does lend itself to exploration in the domain
of simulation. In particular, it may be possible to replace the IPS with a
system based on interactive voice technology. The Navy has had some
success with this approach in training air controllers for precision approach
radar tasks and is in the process of applying the technology to training
air intercept controllers, the Navy's AWCs (Reference 21).

Failure to resolve this issue means that early training experiences for
AWCs will continue to be unrealistic. It is possible that training time could
be shortened if optimal use were made of IPSs or if an interactive voice
system was implemented, given that the concept is proved valid.

## Lack of AWACS-Oriented Block of Instruction in
## AWC Fundamentals of APQ Courses

This issue is primarily a matter of policy and presumably will be resolved when it is decided which half of the initial AWC training pipeline will feed AWACS. The consequence of not resolving this issue is wasted training time for AWACS-bound AWC students.

## Lack of Instruction for Supervisors, Battle
## Staff Personnel, and Decision-Makers

Formal training for these categories of personnel is lacking and the informal training is so unsystematic and unstructured that its effectiveness and efficiency is vitiated. This deficiency is critical because these persons are critical to effective team functioning; they provide leadership, management of the team's resources, and quality control of the team's processes. The level of the team's proficiency in normal operations is dependent on these roles but they are probably more critical in the team's capacity to adjust to emergencies, unanticipated conditions, high workload, and stress.

Some formal systematic training should be provided for these positions in all $C^2$ systems. Unfortunately, the job activities are complex and semi-structured at best. Training technology has neither the concepts, the tools, nor the analytical techniques to develop and implement this type of training. At least, the training community generally believes that it does not. There is a tendency to identify this domain as consisting of "decision making" and "emergent situations" and throw up one's hands in resignation over their intractability.

In reality, little analysis of these kinds of jobs has been done. Related analytical work has been done by, for example, Nickerson and Feehrer (Reference 22) and Ramsey and Atwood (Reference 23). The terminology and concepts are available to provide a framework to describing these jobs. Furthermore, the behaviors in these jobs do not consist wholly of unanalyzable decision-making and spur-of-the-moment inventions in response to emergent events. The activities are largely reducible to goals, principles, and rules, and the use of skilled routines of analysis, interpretation, and implementation.

An important skill is monitoring complex, dynamic events and information to detect events and conditions that require action. An approach to training of monitoring skills was developed by McCutcheon and Brock (Reference 24), and Riley and McCutcheon (Reference 25). Their objective was training watch officers on naval combat ships in tasks of monitoring and evaluating. They used an instructional strategy of observational learning and a video-tape medium. Significant improvements in performance were obtained and the method is neither elaborate nor costly.

## $T^2$ PROGRAM EVALUATION AND MODIFICATION

Two of the issues discussed in the definition development areas are directly related to weaknesses of program evaluation. These are 1) the lack of objective criteria and standards for evaluating team-oriented skills, individual and team readiness, and system effectiveness; and 2) the lack of analytic techniques and empirical data for determining institutional and operational $T^2$ requirements and objectives. Valid $T^2$ program development, evaluation and modification must await the successful

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resolution of these two issues. However, there are two issues specific
to program evaluation that can be dealt with independently.

## Lack of Valid Evaluative Measures for Initial and Initial Transition Training Programs

Current institutional (ATC and TAC) training program evaluation techniques
include the use of questionnaires for two purposes. First, the students are
given an opportunity to critique the course they have just completed. Second,
operations training program personnel are surveyed by ATC and TAC
institutional personnel to determine if student skills and knowledge meet
expectations.

Institutional training program managers are as responsive to this information
as they can be within the limits of policy and available resources. But
several factors work against the utility and validity of the information
produced via the questionnaires. The students are not always in a position
to judge whether they have been trained effectively or to a sufficient level
of proficiency. Also, they tend to be less outspoken and critical for fear of
adverse effects on their record. But these factors do not have an especially
noticeable negative impact.

The nature of feedback from the field is more severe in its impact. Each
operational location has local operating procedures, some of which represent
special cases and therefore deviate from standard procedures taught in the
institutional environment. Furthermore, because the task of controlling
aircraft is in large part technique, the biases of individual controllers come
into play in any criticism that is offered. Different units may come to

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represent different schools of thought on techniques for controlling, depending on experiences. AWACS, SAGE units, and TACS units are subject to this latter problem, but local operating procedures only impact SAGE and TACS units. The institutional environment emphasizes standardization to an even greater degree than the operational environment. Consequently, institutional training cannot be responsive to these demands regarding procedures and techniques. The net result is that all feedback from the field is taken with a grain of salt. The danger is that institutional training programs can wind up operating in an open-loop situation and take on a separate existence.

Several approaches could be taken to closing the loop between operational and institutional environments. Better survey instruments could be constructed with the problems noted above in mind. Simply raising the level of awareness of training program managers might have a positive effect. Effective program evaluation techniques need to be implemented with a cooperative rather than a parochial attitude.

## Incomplete Use of Existing Evaluative Data for System Exercises and Simulated Combat Missions

The AAR is not used to its fullest advantage in program evaluation and modification. The AAR is used by stan/eval personnel in operational units to characterize the system exercise performance of the unit. An individual AAR may have an impact on the design of the subsequent exercise. In any event, the deficiencies noted in the report are the subject of review and corrective action.

Despite their obvious utility, the AARs seem to serve only as a one-shot mechanism. Rather than file each AAR away to be forgotten, it would seem that a compilation of AARs for a particular system, perhaps with some analysis and synthesis, would yield a data base descriptive of positive and negative aspects of performance during training exercises. At the very least this data base could be used as a reference for new team members, especially supervisors; at most it might provide a useful input into developing a taxonomy of team-oriented behaviors.

If this issue goes unresolved, an opportunity to make a positive contribution to $T^2$ would be lost. There should be a high payoff for a small investment.

## PERSONNEL POLICY AND RESOURCE CONSTRAINTS

### Low Retention of Experienced $C^2$ System Personnel

Low retention rates are apparently the result of such factors as low pay, poor work conditions or assignments, little job satisfaction, and the lack of clear career paths and attainable objectives. The resolution of this issue is a matter of policy and budget rather than research and development, with the exception that attitude surveys might be useful in pinpointing problem areas and providing prescriptions for policy decisions.

The consequences of not resolving this issue might be rather severe, depending on how low the retention rate actually gets. The importance of experienced individuals to successful institutional and operational training and to the achievement and maintenance of combat readiness cannot be overestimated: Definition and development of training requires subject-matter

expertise in $C^2$ systems and tasks; the primary method of training is the master-apprentice model; program evaluation depends upon the professional opinion of qualified experts, and so on. If there were a cost-effective method for capturing the requisite knowledge and skill in a computer (software) model of a $C^2$ system expert, then it should be implemented. Barring favorable policy and budgetary decisions, this might be the only feasible solution.

## Shortage of Live Flying Intercept Events and ECM Activities for $T^2$

It is often claimed, and our survey was no exception, that there is no substitute for the experience of controlling live aircraft. It is argued that the same level of stress, the so-called pucker factor, cannot be produced through simulation. (This would seem to be an empirical issue, however.) An AWC must know that lives are on the line to find out if s/he can indeed control proficiently. The same notion also applies to teams, in the sense of survival and mission success. Obviously, live flying is necessary for evaluative purposes as well.

Given the necessity of live events for $C^2$ training and evaluation, some problems have resulted from force and budget reductions in recent years. These would seem to be constraints that must be lived with. Fuel for aircraft will not get cheaper. The prospect of increased live flying to support $C^2T^2$ is unlikely. What can be done?

Ironically, empirical research to determine the relative contributions of live and simulated events to training and proficiency would require live resources in a quantity that is probably unattainable. In addition, the cost of obtaining simulators with high enough fidelity to warrant investigation is prohibitive given present resources and priorities. One approach would be to justify increases in fidelity on logical argument alone.

## Lack of Instructor Training and Evaluation in Operations Training Programs

This issue is a matter for policy rather than training research and development, because current technology would support such training and evaluation. An operational command could receive support from the Air Training Command in establishing an instructor training program. Failure to resolve this issue means that operations training will continue to be less effective than it could be otherwise.

## Difficulties Posed in Training and Evaluating Soft as Opposed to Hard Teams

There are elements of this issue which are appropriate for research and development but the basic issue of team stability is a personnel policy matter. The manpower available is a critical factor in any decision regarding team stability. The key research questions which must be addressed concern 1) the effect on team skill acquisition of constantly-changing team members, and 2) the proper approach to determining soft team combat readiness and effectiveness of systems manned by soft teams. (For a similar view expressed from the Navy perspective, see Reference 20, p. 13.)

It seems evident that, early in training, constant switching of team members would tend to retard skill acquisition. On the other hand, however, in the long term such experience may lead to more adaptable team members. Will these intuitions be proven with experimentation?

Although it is possible to evaluate a team's performance given proper criteria and standards, it is unclear what the meaning of such an evaluation would be if the team were composed of individuals who might not work together again. This is especially disconcerting if one is attempting to measure and generalize about readiness. How does one obtain a valid measurement?

The resolution of these research questions is imperative. Without answers, team training and evaluation must continue to go without data that is much-needed to aid personnel policy decisions.

## Inadequate Understanding of $C^2T^2$ Pipeline by Training Program Managers

This final issue is a matter of personnel policy and requirements; it does not require research for resolution.

Current training technology can provide suitable training packages or criteria for selection of training program managers. The authority to develop such information must first be given. The consequence of not resolving this issue is to accept the status quo with its evident program management weaknesses. A clearer understanding of the entire $C^2$

training system by individual program managers will equip them to better evaluate, modify, and/or develop portions of the course(s) they administer.

## Conclusion

The state of $C^2T^2$ in Tactical Air Command was surveyed and summarized. Training was best in individual initial training in institutional settings. Team training and in-unit, operational training was more rudimentary. ISD procedures are used for individual training but team training is unsystematic. Team training is usually dominated by operational activities that are feasible in terms of available resources rather than by identified training needs.

Systematic definition and development of training for teams and team skills is virtually nonexistent. There is no formal training for supervisory and battle staff personnel, who are critical to the effective operation of teams.

Simulation is used for systems like AWACS and CRC/CRP but the number and capability of these devices is less than adequate. The simulation facilities in $AFC^2T^2$ are significantly behind the state of the art. Facilities which can provide exercise of units as integrated teams and joint exercises of two or more units, such as Blue Flag, have serious limitations.

Issues and problem areas were identified and discussed. They will be treated further in other volumes. They are treated in two groups: those that require longer-term research and those that can be addressed and solved in the short term using currently available technology.

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PREVIEW OF VOLUMES II-V

The identification of issues and problem areas completes Volume I of this report. The next volume (II) presents recommendations for a research program which would address resolution of each of the issues in a systematic fashion. Volume III discusses those aspects of issues or problem areas that can be addressed through the immediate application of available or refineable technology. In Volume IV the functional characteristics required in a simulation facility to support the recommended research topics are described. Finally, Volume V presents a summary of the entire research effort.

APPENDIX A

AFC$^2$ SYSTEM DESCRIPTIONS

AABNCP      (Advanced Airborne Command Post)

| | |
|---|---|
| Major Command: | SAC |
| Development Agency: | ESD |
| Deployment Site(s): | Offutt AFB, Nebraska |
| Current Status: | |

## Description

Function--AABNCP has been undertaken to remedy the limitations of space, endurance, and communications capability, as well as vulnerability to nuclear effects associated with the EC-135 aircraft. The improvements include increased communications capability, enhanced hardness against electromagnetic pulse, increased endurance, and a larger battlestaff area. It will allow antijam secure voice and data communications to major commands. It will use an E4 (Boeing 747) aircraft. Phase I of the program is complete; three D4 planes were equipped with the $C^3$ equipment from existing EC-135 aircraft. The present phase involves the development and testing of advanced $C^3$ capability. A decision will then be made on the procurement of additional $C^3$ packages and aircraft. Projected fleet size is six aircraft.

Team Composition--Command Staff

Related Systems--

- SACCS
- ALCC/ALCS
- AUXCP

Contact--

ABNCP          (Airborne Command Post)

|                     |                    |
|---------------------|--------------------|
| Major Command:      | SAC and NCA        |
| Development Agency: | ESD                |
| Deployment Site(s): | Offutt AFB (SAC HQ)|
| Current Status:     | Operational        |

## Description

Function--The objective is to provide NCA and SAC with a highly survivable $C^3$ system that will operate reliably during all phases of a general war. The older EC-135 aircraft now employed by the National Emergency Airborne Command Post (NEACP) and SAC will be replaced during AABNCP with E-4 aircraft.

Team Composition--Command Staff

Related Systems--

- AUXCPs (Auxiliary Airborne Command Posts)--Augments ABNCP with relay and Airborne Launch Control Systems (ALCS) on ground alert 24 hours/day. ALCS aircraft as well as ABNCP and AUXCPS have capability of launching entire Minuteman missile force if they lose ground control.

Contact--

ALCS            (Airborne Launch Control System/ALCC)

| | |
|---|---|
| Major Command: | SAC/SAMSO (Space and Missile System Organization) |
| Development Agency: | ESD |
| Deployment Site(s): | Offut AFB |
| Current Status: | Operational and developmental |

## Description

Function--ALCS is being updated to receive data via a data link from Minuteman silos and to retarget missiles remotely to the command data buffer capability available in the missile launch control centers. This capability will provide a highly survivable launch platform for status and retargeting. This improves force effectiveness by allowing retargeting of remaining missiles to the highest priority targets.

Team Composition--

Related Systems--

- ABNCP
- AUXCP

Contact--

ICMB Program Office
Deputy MGen A.W. Hepfer
(714) 382-6014

AWACS          (E-3A Airborne Warning and Control System)

| | |
|---|---|
| Major Command: | TAC |
| Development Agency: | Air Force Systems Command, ESD, Hanscom AFB |
| Deployment Site(s): | Tinker AFB, Oklahoma (one of several) |
| Current Status: | Acquisition and operational |

## Description

Function--Provides survivable airborne air surveillance capability and $C^3$ functions. Its distinguishing technical feature is the capability to detect and track aircraft operating at high and low altitudes over both land and water. Aircraft may deploy throughout the US and overseas to provide surveillance, warning, and control in a wide variety of peacetime and wartime situations. E-3A is a Boeing 707 jetliner equipped with an advanced "look-down" Westinghouse radar linked to sophisticated data processing equipment. The system has intrinsic, indirect self-defense capabilities.

## Team Composition--

- Officers trained at Tyndall
- ES trained at Keisler

## Related Systems--

- JTIDS (tri-service Joint Tactical Information Distribution System) involves the development of three classes of terminal equipment. Class I terminals provide a jam-resistant secure, high data rate means to transmit information from large aircraft, such as the E-3A, to ground and airborne forces. JTIDS will be developed in the AWACS context. JTIDS links Honeywell video and other data links to TACS and NATO. Air Defense Ground Environment system provides input to TACC/TACS.

- JSS/SAGE--In wartime, the E-3A will deploy to ACCOM bases and interface with SAGE/JSS personnel.

## Contact--

Deputy BGen G.W. Rutter
E-3A System Program Office
(617) 271-2711

BETA (Battlefield Exploitation and Target Acquisition)

Major Command: Joint Army, Air Force, and DARPA

Development Agency:

Deployment Site(s):

Current Status: Development

Description

Function--A joint source project to develop and demonstrate a test bed consisting of three mobile fusion centers for near-time integration of data from a variety of surveillance sensors. The goal is better information for maneuvering and targeting purposes. BETA will speed up the targeting process via rapid identification/location of key targets and the distribution of this information to firepower elements. BETA will demonstrate the feasibility of computer-assisted decision-making. It will enhance management of surveillance and reconnaissance forces and assist in the prioritizing of specific targets and effective weapon use.

Team Composition--

Related Systems--OASIS: BETA is a smaller, mobile system designed to complement OASIS at the air wing level for target acquisition. BETA will use small processors for target allocation whereas OASIS is used by field commanders for allocation of a large number of forces.

Contact--

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BMEWS TOR UPGRADE (Ballistic Missile Early Warning System Tactical Operations Room Upgrade)

| | |
|---|---|
| Major Command: | Successor to ADC |
| Development Agency: | |
| Deployment Site(s): | I. Greenland |
| | II. Alaska |
| | III. England |
| Current Status: | Modification and analysis |

Description

Function--Upgrading sites is expected to reduce operations staff required by half--will be installing new display consoles and automation techniques.

- At sites I and II, new operator consoles will replace obsolescent consoles to improve operating efficiency and reduce number of personnel.

- At site III, proposed follow-on will provide new computers, improve resolution capability on radar electronics, and upgrade the Tactical Operations Room.

Team Composition--

Related Systems--NORAD

Contact--

JSS                (968 H Joint Surveillance System) Replaces SAGE/301C

     Major Command:              ESD/FAC

     Development Agency:         ESD

     Deployment Site(s):

     Current Status:             Validation/acquisition

## Description

Function--Program has been established to acquire and deploy a peacetime
air surveillance and control system to replace the SAGE and BUIC (backup
interceptors command) facilities for US and Canada.  The strategy is to get
people out of the operating loop.  For Canada, the mission is expanded to
include support of wartime air defense functions and in Alaska the mission
includes the performance of tactical air control functions.  In wartime,
JSS would be supplemented by the E-3A AWACS.

Team Composition--

Related Systems--SAGE/BUIC

Contact--

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JTIDS (Joint Tactical Information Distribution System Mystic Link)

    Major Command:        Joint Air Force/Navy/Army program

    Development Agency:    ESD

    Deployment Site(s):

    Current Status:        Engineering development

## Description

Function--A key digital information distribution system which will be secure, jam-resistant, and survivable, will have sufficient capacity range to provide current combat and relative position information to all tactical force elements on a near real-time basis. May be first field system to use very-high-speed integration circuitry. Will connect AWACS, ground and shipboard $C^2$ and surveillance centers, and combat and support aircraft. May be adopted by NATO allies for their tactical data needs.

Team Composition--

Related Systems--AWACS/TACS

Contact--              Joint Program Office
                    ESD, Hanscom AFB
                    Col. Brentnall, Deputy Manager of the Joint
                        Program (617) 271-2714
                    Lt. Col. Buckelew, Deputy Program Manager
                        for Air Force (617) 271-2714

MISSILE LAUNCH

| | |
|---|---|
| Major Command: | SAMSO/SAC |
| Development Agency: | ESD |
| Deployment Site(s): | Vandenberg AFB |
| Current Status: | Operational |

Description

Function--Missile launch control room, Minuteman.

Team Composition--

Related Systems--

- ABNCP
- ALCC

Contact--

NORAD COC        (North American Air Defense Command
                 Combat Operation Center)

|  |  |
|---|---|
| Major Command: | Successor to ADC |
| Development Agency: | |
| Deployment Site(s): | Cheyenne, MT; Colorado Springs, CO |
| Current Status: | Acquisition, deployment, upgrade |

## Description

Function--NORAD COC is an aerospace surveillance and communications
network which is to provide unambiguous and early warning of a potential
ballistic missile attack and provide this information to the NCA, Canadian
Defense Staff, USCINCVEVR, CINCLANT, CINPAC, and CINCSAC.

## Team Composition--

## Related Systems--

- BMEWS
- Perimeter Acquisition Radars
- SLBM Warning System (PAVE/PAWS)
- FPS-85 Radars
- Infrared Launch Detection Satellites (and other satellites)
- Integrated Operational Nuclear Detection System (IONDS)
- Space Detection and Tracking System (SPADATS)

## Contact--

OASIS            (2394 Operational Application of Special Intelligence Systems)

| | |
|---|---|
| Major Command: | USAFE |
| Development Agency: | |
| Deployment Site(s): | Ramstein AB, W. Germany |
| Current Status: | 1978--development and acquisition |

## Description

Function--Improvement of tactical $C^3$ capabilities through the application
and interfacing of appropriate surveillance and special intelligence systems.
Intended as an automated system that links the intelligence world and the
operations world, with the objective of enhancing tactical command and
control activities in NATO. OASIS will initially use off-the-shelf hardware
and software, originally designed for peacetime flight-following computer
systems, and apply them to assist decision-makers in handling wartime
resource allocations. OASIS will be used by field commanders for allocation
of large numbers of forces.

Team Composition--

Related Systems--BETA is designed to complement OASIS at the air wing
level for target acquisition. BETA will use small processors for target
allocation.

Contact--

SACCS            (Strategic Air Command and Control System)

    Major Command:    SAC

    Development Agency:    ESD

    Deployment Site(s):    Offut AFB

    Current Status:    Operational

Description

Function--

Team Composition--

Related Systems--

- ABNCP

- ALCC

Contact--

SATIN IV          (SAC Automated Total Information Network)

    Major Command:          SAC

    Development Agency:

    Deployment Site(s):

    Current Status:         Doubtful

<u>Description</u>

<u>Function</u>--Will be a record data communications system for SAC and a
SAC subsystem of WMCCS.  As such will provide secure, two-way
channels of communication between the National Military Command System
(NMCS), CINCSAC, and SAC missile and aircraft combat crew members.

- <u>SACDIN</u> (SAC Digital Network)

  Formerly SATIN IV--scaled down in response to congressional
  demands for lower costs.  SACDIN's purpose is to furnish
  highly responsible, functionally survivable, and secure
  communications between SACs Commander-in-Chief, the
  NCA, and SAC missile and bomber/tanker command posts.

<u>Team Composition</u>--

<u>Related Systems</u>--

<u>Contact</u>--

SPADOC            (Space Defense Operations Center)

    Major Command:

    Development Agency:

    Deployment Site(s):

    Current Status:            Development

## Description

Function--An early segment of the developing Space Defense Command and Control System, SPADOC is scheduled for procurement in FY 1980. In FY 1979 a detailed design will be developed for SPADOC. The SDCCS, when developed, will identify outputs from the current SPACETRACK. It will define input and routing for maintaining status of US satellites, identification of forces of use of satellite, and define command and control for reporting warnings of attack, attack impact on forces, and determining and reporting attack verification.

## Team Composition--

## Related Systems--

Contact--            ESD, Hanscom AFB
                     A. Salvucci, Deputy Program Manager
                     (617) 861-5432

TACC                (Tactical Air Control Center)

    Major Command:          TAC

    Development Agency:

    Deployment of Site(s):  At least Eglin AFB (in support of Blue
                            Flag exercises)

    Current Status:         Development and acquisition production
                            decision planned in FY 78

## Description

Function--Operations center and focal point for all air activity within TACs.
Coordinates the employment of tactical air effort and air control functions
in area of operations.  Has four groups: 1) Combat Operations Weapons
Employment, normally referred to as Current Operations. 2) Combat
Operations Plan, normally referred to as Current Plans, which centralize
collection, evaluation, and display of information on the air situation.
These two operational groups have parallel groups in intelligence.
3) Fusion, which deals in real-time data collection and parallels the
combat operations weapons employment. 4) Intelligence, which parallels
the Combat Operations Plan.

Team Composition--Command Staff Positions

Related Systems--AWACS

Contact--              Tactical Air Control Center
                       ESD, Hanscom AFB
                       Col. T. Duff, Deputy Program Manager
                       (617) 861-4952

TACS                (Tactical Air Control System)

    Major Command:

    Development Agency:

    Deployment Site(s):

    Current Status:

## Description

Function--The detection, display, and control equipment of the 485L TACS provide command personnel assistance in evaluating the current situation and directing the deployed forces in accomplishing the counter-air inter-diction, close-air support, reconnaissance, assault airlift, and special missions. Four subsystems support the Tactical Air Commander and his task organizations:

## Subsystems

1) AC&W (Aircraft Control and Warning)

    --Detection, identification, and control of all aircraft movement within a designated area of responsibility.

2) DAS (Direct Air Support Subsystem)

    --Gives fast reaction capability to satisfy immediate requests from ground forces for close-air support, reconnaissance, and assault airlift.

    Functions carried out by:

        DASC (Direct Air Support Center)

        TACP (Tactical Air Control Parties)

3) ATC (Air Traffic Control)

    --Promotes the safe, orderly, and expeditious flow of air traffic, including non-combat aircraft--provides maximum airspace use.

    Functions carried out by:

        ATRC (Air Traffic Regulation Center)

        TATCF (Terminal Air Traffic Control Facility)

4) Communication Subsystem

--Provides transfer medium for much of the information flowing
through TACC system.

<u>Team Composition</u>--

<u>Related Systems</u>--AWACS

<u>Contact</u>--

TAC CIC      (Tactical Air Command   Combat Information Center)

Major Command:         USAFE
Development Agency:
Deployment Site(s):    Europe
Current Status:

Description

Function--

Team Composition--

Related Systems--

Contact--

TACSI          (Tactical Air Control System Improvements) 485L
               (407-L follow-on)

    Major Command:

    Development Agency:

    Deployment Site(s):    Eglin AFB, Shaw AFB, Bergstrom AFB

    Current Status:    R&D Acquisition

## Description

Function--This program gives TACS increased operational capabilities
needed for combat $C^3$ of tactical aerospace operations. Improvements
consist of mobile communications and electronic systems capable of
modular world-wide deployment that are compatible with TACS and
interoperable with Army, Navy, and Marine Corps tactical data systems.
(F&S 6.12)

Team Composition--

Related Systems--TACS, AWACS

Contact--

TIPI        (Tactical Information Processing and Interpretation System)

  Major Command:          TAC

  Development Agency:      ESD

  Deployment Site(s):

  Current Status:         Development, acquisition, and deployment

Description

Function--TIPI provides the capability to rapidly exploit the information
collected by reconnaissance aircraft.  Its objective is the development of
air-transportable facilities that provide for processing, reduction, and
interpretation of aerial reconnaissance and surveillance products, and to
collate this with intelligence from other sources.

Terpes is one segment of the TIPI system--to provide ground processing
capability for determining and reporting location and operating parameters
of enemy surface emitters.  (TEREC → TERPES → TIPI)

Team Composition--

Related Systems--AWACS/TACS

Contact--              Hanscom AFB
                       Col. J. Ostrominski, Deputy Program Manager
                       (617) 861-4144

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TRACALS        (Traffic Control and Landing Systems)  404L

    Major Command:

    Development Agency:        ESD

    Deployment Site(s):

    Current Status:        Continuing acquisition

Description

Function--Fixed and mobile ground facilities and equipment, with
associated avionics to update the USAF air traffic control function.

Team Composition--

Related Systems--TACS

Contact--

TRI-TAC          (Joint Tactical Communications)

Major Command:        TAC

Development Agency:    Ft. Monmouth/ESD

Deployment Site(s):

Current Status:         Development

## Description

Function--A single program to acquire and field a modern, secure, multichannel tactical communication system for all services. While achieving interoperability, the goal is to eliminate duplication and reduce costs. The Director of TRI-TAC is the architect, the systems engineer, and the manager of the program. The Air Force has been tasked with five TRI-TAC development programs.

For the purpose of $C^3T^2$ only, the Tactical Communications Control Facility (TCCF) is of importance. The TCCF will perform the communications management, near-real-time control, and technical performance monitoring functions for a communications system.

Team Composition--

Related Systems--

Contact--

USAFE TFC/COIC       (Tactical Fusion Center/Combat Operations
                      Information Center)

    Major Command:        USAFE

    Development Agency:

    Deployment Site(s):   Europe

    Current Status

Description

Function--

Team Composition--

Related Systems--

Contact--

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APPENDIX B

DATA COLLECTION METHODS

AND

DATA COLLECTION INSTRUMENTS

APPENDIX B

DATA COLLECTION METHODS AND DATA COLLECTION
INSTRUMENTS

## DATA COLLECTION METHODS

In order to achieve the objectives of this research effort it was necessary
to carry out several different types of data collection. The approach was
twofold: 1) a review of relevant literature and technical documentation
and 2) a field survey consisting of interviews of training personnel and
observations of training.

### Literature and Technical Documentation Review

This section discusses three aspects of the review. A major initial input
to this effort was an AFHRL review of the literature on team training
research (Denson, 1980). Other relevant literature, for example, in the
area of $C^2$ decision-making, was identified during the course of this effort
and was reviewed. Technical documentation concerning Air Force $C^2$
systems was examined to provide rationale for survey site selection, as
discussed in the Field Survey section. Also, during the site surveys we
gathered documentation on training programs including course outlines
and materials, training development information and evaluation materials,
and on the system planning, development, and acquisition process.

AFHRL Literature Review--This $T^2$ literature review examines definitional
issues and those related to characteristics of individuals, tasks and teams,
feedback and performance objectives, and measurement. Also included is
the applicability of instructional system development (ISD) techniques to
the development of $T^2$.

The review served to focus the topics of data collection. The issues raised
in the review certainly exist to one degree or another in the $C^2T^2$ area.
In Chapter 3 of Volume I and in Volumes II and III, previous research
results are brought to bear on the analysis and evaluation of $C^2T^2$ in the
Air Force.

Additional Literature--As the research progressed and $T^2$ issues suggested themselves, additional information sources were sought. Reports unavailable for the AFHRL review were identified and reviewed. The results of this activity will be evident throughout this report as the literature reviewed is given appropriate reference.

Technical Documentation--This documentation falls into two categories: 1) $C^2$ systems and 2) training program and system acquisition materials. The literature on $C^2$ systems was reviewed to determine system nature, status, and deployment. The primary source for such information was articles in various Armed Forces and electronics magazines. Selection of sites to be surveyed was based in part upon data from this review.

During the data collection effort, we obtained numerous documents and materials pertaining to various aspects of Air Force training; system-specific training and $T^2$; $C^2$ systems specification, design, and acquisition; and the like. This data has been thoroughly integrated into Chapters 2-4 of Volume I, forming a portion of the description of $C^2T^2$ status. The material is referenced as appropriate throughout and is included as appendixes where appropriate.

Field Survey

There are three aspects of the field survey which must be discussed: population, methods, and site visits.

Survey Population--Preliminary considerations in matching methods to objectives involved identifying the types of personnel who would contribute to the research data base.

Training personnel clearly had to form a major part of the sample. Design and development, implementation, and evaluation are the important stages in a training program's life cycle. Therefore, personnel involved in each of these stages had to be interviewed; these personnel include managers, training technologists and instructional system designers, instructors, evaluators, and students. In addition, because there is an intimate relationship between $C^2$ system capabilities and training requirements, the $C^2$ system acquisition process had to be examined to reveal when and where training considerations impact system design. Therefore, $C^2$ system acquisition planners had to be interviewed.

Because it was desired to informally evaluate $T^2$ program success, operational unit supervisors/commanders also had to be interviewed when possible. It was expected that these individuals could provide us with insight as to the suitability and effectiveness of earlier training and any necessity for accomplishing further training. By way of preview, in all cases the operational units we surveyed were at once users and trainers, so this approach was convenient and productive.

In order to make recommendations for the establishment of a $T^2$ research and development (R&D) program, it was necessary to survey future $C^2$ system capabilities. A meaningful $T^2$ R&D program is dependent upon a valid assessment of future $T^2$ requirements, which in turn depends upon future $C^2$ team tasks and structure. Achieving this objective required a survey of the status of $C^2$ technology development; thus, knowledgeable Air Force and industry personnel were interviewed.

Survey Methods--The survey requirements were met through interviews and observations (and technical document data collection, as noted above). The interviews and observations were guided by data collection instruments (DCIs) developed specifically for this effort. The DCIs were developed in a three-step process, as discussed next.

DCI Development--The first step in DCI development was to clearly define the areas of emphasis and information objectives of the effort. The results of this step were the specification of content areas and questions to be asked or observations to be made within each. The approach was to develop interview schedules for each type of respondent who would contribute to the data base, and to develop a general observation guide which would be applicable to all training to be observed. Five DCIs were developed for interviewing:

- Training program manager/developers
- Instructors
- Students and recent graduates
- Operational unit supervisors or commanders
- Systems Program Office staff

One observation guide was developed. The DCIs are presented at the second part of this appendix.

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The second step in DCI development was determination of a preliminary format and contents for review and use during early data collection efforts.

A review of the literature on interview techniques revealed a useful distinction between interview schedules and guides (Gorden, 1969). A schedule refers to a highly structured and detailed format in which all topic areas and questions to be asked and their sequence are specified for the interviewer. A guide refers to a format which includes the topic areas and some example questions or probes. There is no order of coverage implied and the guide may be used as a memory aid or checklist. The guide format was judged desirable since it permits a more natural and freewheeling interview and ensures the gathering of information pertaining to all topic areas, but does not stifle spontaneity or in-depth coverage of particularly productive or unanticipated topics.

The guide format was also chosen to assist data gathering during the observation of training. The topics selected for observation specify the characteristics of equipment, training programs/exercises which were to be observed during site visits.

Before finalizing the preliminary DCI format and contents, a draft version of the guide for interviewing the Training Program Managers/Developers was used in interviews with two Honeywell personnel. These personnel were responsible for developing the individual and $T^2$ for the Army's Stand-Off Target Acquisition System (SOTAS) program. This approach permitted the interviewers, before going into the field, to determine a natural order of topics for discussion, and the utility of phrasing questions in certain ways. It also helped to sharpen their interview skills. Also, information regarding current approaches to $C^2T^2$ (SOTAS is a $C^2$ system) was added to the data base.

This approach was not possible with the observation guide, since the SOTAS training program was dormant at the time. However, observation by its nature lends itself to change; it is a more flexible data gathering technique than interviews, so the risk in this area was small.

The third step in DCI development was revision of the instruments based on actual use in the field and review with AFHRL. As discussed below, the interview format underwent some changes based on experience, but the content of the interview and observation guides did not change.

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DCI Use--The field environment is not as controllable as the confines of the laboratory. The DCIs were used as planned when such use met the objectives of the study. However, meeting the objectives occasionally called for plans to be modified. The approach chosen was flexible enough to permit the necessary modifications.

The plan for interviews was to use to interviewers with one respondent. The interviewers were to operate as a team, one asking questions, the other taking notes. Because it was projected that the interviews would be long, on the order of two to four hours, it was planned that the interviewers would switch roles about halfway through the session. In addition, in order to relieve the burden on the note taker, it was decided to tape record the interviews, not for the purpose of transcription, but only to supplement and clarify notes. Finally, it was planned to interview all respondents individually, with the exception of students and recent graduates, who were to be interviewed in small groups.

Observation of training and exercises was to be non-instrusive to the ongoing activity. Each training program or exercise observed was to be followed by a debriefing of a representative sample of the personnel involved. The format for these debriefings was planned to be the same conversational, flexible approach adopted for the interviews.

The interviews proved to be at least as time-consuming as anticipated, in fact, more time than planned was required during early site visits and so the length of time set aside for each trip was expanded to give maximum flexibility. The two-interviewer format was dropped when time during a site visit ran short, but this occurred after the early site visits. By that time the interviewers had polished their skills and become conversant in the particulars of Air Force $C^2T^2$. Also, to save time, non-student respondents, for example, instructors, were occasionally interviewed in small groups averaging three to five individuals.

Early in the study it was determined that the tape recorder created more problems than it solved. Notes and follow-up conversations proved sufficient to gather the needed data so dispensing with the recorder did not affect the validity of the effort. The problems with the recorder included possible inhibition of conversation and inconvenience in its use. The tapes were helpful in validating the general interview approach but proved difficult to use as a memory aid for specific instances. This was because the specific instances in question had to be retrieved from three or more hours of recording, which consumed significantly more time than a follow-up phone call.

Another modification in method evolved over the course of the study. The interviews during early site visits were conducted by following the guides very closely. At any particular site, however, there proved to be topics the content of which remained the same from respondent to respondent. It was therefore redundant and wasteful of time to pursue certain topics, for example, system configuration, with more than one or two respondents at each site. Additionally, as the interviewers became conversant in $AFC^2T^2$ and internalized the topics and probes of the interview guide, the interviews became increasingly natural, cogent, and productive. Toward the end of the site visits the interview guides actually become superfluous and, in fact, it would have been counterproductive to depend on them to any large degree.

The observations were carried out as planned. They were non-intrusive to ongoing training or exercises. The generalized guide included in this appendix was suitable for all observation during this study effort.

Site Visit Protocol--The protocol to be followed for each site visit was straightforward. The steps were to establish a point of contact, make a formal request and arrange the visit, conduct interviews and observations, and follow up the visit with a letter of appreciation.

As each site was identified, a request for cooperation was submitted by AFHRL. The request asked that a point of contact be named for the proposed visit. This individual was then contacted by Honeywell and the scope of the study was discussed. The primary purpose of the discussion was to ensure that interviews with appropriate individuals would be arranged and that observations of training would be permitted. Once the details of the visit had been worked out, Honeywell made a written formal request for on-site support, including copies of a list of general interview topics for distribution to the designated respondents. This distribution preceded the actual visit by one to seven days in all cases.

During the site visits, the point of contact generally provided an orientation to the unit or program. Interviews of knowledgeable personnel were conducted, interspersed with observations of actual and training equipment, training, and task performance of operationally ready teams. Before concluding the visit, the point of contact and unit commander (occasionally these were the same individual) were debriefed as to whether the site visit objectives had been met.

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In all cases during the site visits, the support was complete and enthusiastic. The cooperation of all respondents and other participants was commendable. A thank-you letter expressing appreciation for support was sent to each point of contact after the visit. The letter noted the names of all survey respondents. In several cases follow-up phone conversations were made in order to clarify the information obtained.

# REFERENCES

Denson, R., "The Training of Teams" AFHRL-TR-

Gorden, R.L., Interviewing: Strategy, Techniques and Tactics.
Homewood, IL: Dorsey Press, 1969.

INTERVIEW GUIDE:  TRAINING PROGRAM MANAGER/DEVELOPER

Respondent _____ Date _____

Title _____

System _____

Organization _____ Phone _____

Interviewer(s) _____

## Introduction

Purpose--Survey team training programs for operators of $C^3$ systems; identify strengths and determine issues requiring R&D.

Benefit--Improvement of team training programs.

## Warm-up

1. (How long have you been with this program?  What background did you bring to this system - civilian?  military?  What background do you have in training?  In the development of $C^3$ systems?)

System Background and Information

Mission Concept

2. Mission--(What is the stated mission of this system? What
   do you consider the most important features of this mission?)

3. Interface--(Does this system interface with other systems?
   Which systems?)

4. Position--(Is this system considered to be an Air Division,
   Wing, or Group Asset?)

<u>Personnel</u>

5. Team Size:   (How large is the team that operates this system?
                How is this team defined?  Sub-team?  Super team?)

6. Team composition and structure: (Who are the members of the
                team?  What is the composition of the team?  How
                many officers?  Enlisted?  What background?  Which
                team members report to others?)

## Hardware & Functions

7. Equipment--(What computer is being used and what are its
   specifications?  What types of display are used?  What
   equipment is used for data input/output?)

8. Configuration--(How many operator stations are there?
   How modular are the systems?)

9. Function--(How does this equipment support the missions?)

## Tasks

10. Job description--(We know the team consists of ____ people. In terms of the AFSC describe the job of each of the individuals who will man the system?)

11. Equipment--(With what equipment does each individual work? What are his tasks on each piece of equipment?)

12. Information reception—(What sort of data, information or direction will an individual receive? From what source will his information come? In what form will it come?)

13. Information processing—(What is each individual expected to do with the information he has received? What decisions will he make while performing his tasks? What output will be produce? In what form? To whom will he send this info?)

14. Constraints--(Under what sort of time limits will he be
    working?  Under what other constraints?  Which constraints
    affect accuracy?  Communication?  How tolerant is the system
    of human error?)

15. Team tasks--(Which of each individuals responsibilities
    are carried out independent of the other team members?
    Which responsibilities  require communication between team
    members?  Which responsibilities require cooperative
    effort between team members?  Which responsibilities would
    you describe as team tasks?  What else should we know about
    each team task?)

Training Program Information

Existing Training

16. Student background--(What lead-in training have students received when they enter training for this program?)

17. Training environment--(What portion of the existing training is done in a classroom setting?  What does this training consist of?  What portion of training is done on non-operational equipment (simulators/training devices)?  What portion of the training is on-the-job training?  What does this OJT consist of?)

18. Training emphasis--(What emphasis is placed on operating hardware? How much emphasis is placed on tasks done independent of other team members? How much emphasis on system mission and background? How much emphasis on tasks that require communication between team members? Are students taught how their responsibilities combine with other team members to accomplish the mission?)

19. Training media hardware--(How is hardware used as part of the training system? How, if at all, are simulators and training devices used? Which tasks are trained using simulators? What team skills are trained on the device or simulator? What tasks are trained using other media: film, audio recordings, film strips, books, etc.? What are the preferred media? Which don't do the job? How easy is it to modify the media?)

20. Training media software--(What scenarios are used to train team skills? What other capabilities do these training devices have--e.g., how easy would it be to change scenarios? What are the software and hardware limitations of the training device? What sort of documentation is required before changes can be made? What configuration control is there?)

21. Training strategies and objectives--(What approach is used to train students in the tasks which are done independent of other team members?  How are students taught the tasks which require communication between team members?  What other special team training do students receive?  What things can't be taught at all?  What are the objectives of training?)

22. Course features--(How long is training?  What is the sequence?  Is training self-paced?  For individuals?  For teams?  How is feedback provided and when?  What feedback is provided during hands-on training for individuals?  For teams?)

23. Training of tasks information--(Which tasks are taught only partially? How and when will the student learn the full task? Which tasks are taught in full? How will the tasks that are taught only in part be integrated with the tasks which are taught in full? What tasks can best be taught in school? In OJT? Not at all - only learned through practice?)

24. Course content--(What lesson plans are used in classroom? OJT? Using training devices? Which individual tasks are trained using a specific plan of instruction? Which team tasks are learned by the student not through course design but as unplanned consequences of other training?)

25. Performance evaluation & measures--(What performance measures are used? Are these realistic? How is individual performance evaluated? Team? Are norm-referenced or criterion-based standards used for performance measurement? What standards are used to evaluate performances for individuals? What standards are used to evaluate team performance? What measurements/techniques are used to evaluate performance for individuals? For teams?)

26. Attrition--(What is the attrition rate from this program? When does attrition occur? What are the primary causes of attrition? How can attrition be lessened?)

27. Readiness--(After training are the students ready to work on operational equipment or do they require further training? How is readiness judged?)

28.     Training needs--(What areas of the training program could
        be improved?  Is the syllabus adequate?  Training equipment
        sufficient?  Personnel suited to the job?  Do you feel
        there is sufficient emphasis on team training?)

Training Development and Implementation

29. Organizational factors--(Which AF directives/procedures
    are followed in the development of training objectives?
    What is the management structure for development of training
    programs?  How are personnel selected--managers, instructors,
    students?  What are the procedures used to select, train,
    and evalaute instructors--stan/eval?  Management personnel?)

30. Training objectives--(How are training objectives established?
    How are the objectives established in terms of student
    performance?  How are the objectives of hands-on training
    determined?)

31. Task analysis--(Were task analyses done for individual
    tasks? For team tasks? What methods are used to do
    team analyses? How is the task analysis information used
    in developing training objectives and training requirements?
    When is a task analysis done?)

32. Skills identification--(What methods were used to identify
    individual skills to be trained? To identify team
    skills? How is this information used?)

33. Training requirements--(What methods were used to identify
    individual training requirements? To identify team training
    requirements? What makes it hard to identify team training
    requirements? What requirements are easy to identify?
    What makes it hard to identify individual training require-
    ments? What makes it easy? How were team training require-
    ments used in course development?)

34. Simulator/training device--(How is the need for a simulator/
    training device determined?  What methods are used to
    determine individual skills to be trained using a simulator?
    Team skills?  How and who determines that a training
    device is the most appropriate method for training certain
    tasks?  How are training device requirements defined?  How
    are scenarios developed and employed?  How are training
    devices or simulators used?)

35. Hands-on training--(How is the ratio of hands-on training to
    classroom training established?  How are the objectives
    of hands-on training determes the most effective training
    approaches?  Who determines the usefulness of such training
    media as film strips, pamphlets, etc.?)

36. Actual equipment--(How is actual equipment used in training?
    Is the equipment stimulated?  How?  What are the limitations
    of actual equipment?  What are the advantages?)

37. Training program implementation--(What methods are used to take training requirements and turn them into training programs? What limits the effectiveness of this transition?)

38. Team training--(What instructional strategies are used to train team skills? What factors will affect the efficiency of these instructional strategies? How are team performance measures developed? What feedback techniques are used to communicate the results of team performance to team members? Are there any other questions I should have asked?)

39. Program standards--(How are program standards established? How is sequencing established? Do the established performance measures measure that which needs to be measured? Is there any way to evaluate the appropriateness of training device hardware for training the identified skills? of training device software?)

Evaluation

40. Organizational factors--(What AF procedures exist for training evaluation? When are these procedures applied? What do these procedures involve? What personnel are responsible for training evaluation and modification?)

41. Information sources--(What sources of feedback does the program have from the field? From internal sources? How is this information used? Is there any method available to determine whether the skills identified and being trained for individuals are the skills actually required on the job? For teams?)

42. Appropriateness of training--(Is there any attempt made to determine whether the individual skills which have been identified and are presumably being trained are in fact the skills which are being trained?  What individual skills may actually be trained?  Is there any method available to evaluate how indiviudal skill acquisition influences team skills acquisition?)

43. Team performance--(What performance measures are used to assess team skill acquisition?  On training devices?  In the field?  Is there any method used to identify and evaluate the team skills being taught and to compare them to the skills identified as training requirements in program development?  How is "readiness" determined for teams?)

44. Simulator/training device--(How is the effectiveness of training devices/simulators evauated? Is software evaluated for adequacy in accomplishing training? How is this done? When training devices are used, how and when will the performance of students on operational equipment be evaluated? Is there any way to evaluate the appropriateness of training device hardware for training the identified skills? Of training device software?)

45. Team training device--(When training devices are used to train teams--how and when will the performance of students on operational equipment be evaluated? Has there been any effort made to evaluate the effectiveness of training devices which were designed to train individual skills when these devices are adapted for use in training teams?)

46. Modification process--(What modification procedures exist for correcting device deficiency? How well do these procedures work? What are the procedures for improving software? What other procedures exist to modify training material? What procedures are used to modify a team training program? What are the difficulties of modifying a program?)

## Developing/Modifying Training Program

This section will be covered only when a training program is in a period of transition; either when training is just beginning to be developed or when an existing training program is being substantialy modified.

47. Where is this system in the acquisition cycle?

48. System under modification--(What training was done before? What modifications are being planned? Why are they being made? What impact will the modifications have on training objectives and requirements? What other impact is there?)

49. Developing system--(Are training considerations being taken into account during hardware development? What considerations are taken into account? What sources, workbooks, AF procedures/directives are being used to develop training?)

50. Both systems--(What strategies are being used to develop training? Are team training aspects being considered? How will team training be developed? When will task analyses be done? Will a team task analysis be done? How will performance measures be established? Training device needs? Evaluation procedures?)

Training Program Needs

51. (In what ways can this program be improved? What information would help you in the development, implementation, and evaluation of programs? What job aids have you used before and found to be helpful? Suppose we provided you with . . .

A _____ B _____ C _____ D _____ . . . would you find these helpful?)

Respondent Information

52. Background--(What is your AFSC/job description?  What
    does your job actually require you to do?  How many years
    of experience do you have in training programs?  What
    specialized vocabulary have you had to learn?)

53. Job needs--(Do you feel you job could be helped if you were
    given more information and background in instructional
    technology?  How much time would be allowed by your other
    responsibilities to learn more about team training  and
    instructional technology?  What form of information would
    be most helpful to you--self-study, seminars, etc.?
    What other time constraints do you have?  What sort of
    information would give you assistance in your other job
    needs?)

54. Organizational constraints--(When you are managing/developing
    a training program, what sort of management constraints do
    you have?  What about time constraints?  How flexible is
    this organization?  What sort of input do you have in the
    design/development process for hardware?  How rapidly
    can the organizational decision making process meet outside
    demands or changing situations?)

55. Decision points--(What are the critical decision points
    when you are developing a training program?  Who makes the
    final decisions about training?  Where do you fit in the
    decision-making process?  Who are the key people in this
    process?)

Validity Assessment/Interviewer Comments

INTERVIEW GUIDE FOR TRAINING PROGRAM MANAGERS/DEVELOPERS

The purpose of this survey is to obtain information on existing $C^3$ system training programs with special emphasis on team training elements and programs.

System Background and Information
  Mission concept (stated mission, system interface, wing asset?)
  Personnel (team size, definition, structure)
  Hardware (equipment, station number, configuration)
  Tasks (job descriptions, equipment used, communication network, constraints, team tasks)

Training Program Information--Existing Training
  Student background (lead-in training)
  Training environment (classroom vs. equipment vs. OJT)
  Training emphasis (emphasis on mission, team communication, individual tasks)
  Instructional strategies (approach taken in training)
  Training hardware (use of simulators, other capabilities, configuration control)
  Course features (length, sequence, feedback use)
  Course content (lesson plans)
  Performance evaluation and measures (standards for teams, individuals, realism)
  Training needs (attrition, syllabus, training equipment, personnel selection)
  Readiness (how judged)

Training Program Development and Implementation
  Organizational factors (AF directives, management structure, personnel selection)
  Training objectives (establishment)
  Task analysis (who does one, when, how used)
  Skills identification (methods used for individuals, teams)
  Training requirements (identification methods)
  Simulator/training device need (how determined? scenario development?)
  Hands-on training (how developed)
  Actual equipment (use, limitations)
  Training program implementation (how, limitations)
  Team training (development)
  Program standards (establishment of standards, sequencing, measures)

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Training Program--Evaluation

  Organizational factors (AF procedures, personnel)

  Feedback sources (field, internal)

  Appropriateness of training (does training teach identified skills)

  Team performance measures (readiness, requirements)

  Simulator effectiveness (how evaluated? software? appropriateness in training?)

  Team training devices (when evaluated on operational equipment)

  Procedures for program modification (how hard, what is done)

Developing/Modifying Training Program

  Scope of changes

  Purpose of changes

  Strategies for change

Respondent Information

  Background

  Job needs

  Organizational constraints

  Decision points

INTERVIEW GUIDE:   INSTRUCTOR

Respondent _____ Date _____

Title _____

Organization _____ Phone _____

Interviewer(s) _____


Introduction

Purpose--Survey team training programs for operators of $C^3$
systems.  Determine strengths and identify issues for
research and development.

Benefit--Potential increased support of team training programs.


Warm-up

1. (How long have you been with this program?  What did you
   do before you came to this program?  How were you assigned?
   Where did you receive your instructor training?  What are
   your collateral duties?  Is instruction your primary duty?)

## System Background and Information

### Mission Concept

2.  (What is the stated mission of this system?  What do you
    consider the most important features of this mission:
    How do these features affect your instructing?  Does this
    system interface with other systems?  Is this system con-
    sidered to be an Air Division, Wing, or Group Asset?)

<u>Personnel</u>

3. Team Size:  How large is the team that operates this system?
               How is this team defined?  Sub-team?  Super team?


4. Team composition and structure:  Who are the members of the
               team?  What is the composition of the team?  How
               many officers?  Enlisted?  What background?
               Which team members report to others?

Hardware & Functions

5. (How does the system hardware support the mission? What
types of display are used? What equipment is used for
data input/output? How many operator stations are there?
How modular are the systems? What features of the system
hardware make training difficult? From the individual
operator's point of view? From a team point of view?)

Tasks

Individual

6. (Job - In terms of AFSC, would you describe the job of each of the individuals who man the system?  How does the job support the mission or various mission phases?)

7. (Duties - What are each team member's primary duties?  What are the secondary duties?  How do the duties vary as a function of mission phase?  What is expected of individuals in an emergency, e.g., in the event of the loss of a team member?)

8. (Tasks - Discuss the tasks that enable performance of each of the duties described above. What equipment does each individual interface with? What is the nature of the tasks - procedure followed? Decisions made? Data/information gathered? processed? Responses/output generated? What are constraints on task speed? Accuracy? Based on your experience, are there any unique task demands?)

<u>Team</u>

9.  (What are the coordination requirements among individuals
    in the performance of their jobs?  What specific duties
    require coordination/communication among team members?  What
    specific tasks require one individual to provide data/
    information to another?  To receive data/information from
    another?  What are the constraints placed on inter-individual
    task performance - Accuracy?  Anticipation?  Timing?)

Training Program Information

Existing Training

10. (Student background—What lead-in training have students
received when they enter training for this program?
What are entry level skills?  Are entry level skills the
right ones?  Are entry skill levels ap₁ opriate?)

Course Environment

11. (What portion of the existing training is done in a class-
room setting?  What does this training consist of? What
portion of training is done on non-operational equipment
(simulators/training devices)?  What are the completion
level skills or qualifications?  How much training is then
done on-the-job?  What does OJT consist of?

## Course Emphasis

12. (What emphasis is placed on operating hardware?  How much
    emphasis is placed on tasks done independent of other team
    members?  How much emphasis on system mission and background?
    How much emphasis on tasks that require communication between
    team members?  Are students taught how their responsibilities
    interface with other team members?)

## Training Media

13. (How is hardware used as part of the training system?  How, if at all, are simulators and training devices used?  Which individual tasks are trained using simulators?  Team tasks?  How accomplished?  What capabilities do these training devices have--e.g., how are scenarios developed?  How easy would it be to change scenarios?  What are the software and hardware limitations of the training device?  What tasks are trained using other media:  film, audio recordings, film strips, books, etc.?  Which media work best?  Least effective?  Which media are used to train team skills?  Are they satisfactory?  How easy or difficult are these various media to modify?)

## Course Strategies

14. (What approach is used to train students in the tasks which
    are done independent of other team members?  How are students
    taught the tasks which require communication between team
    members?  What other special team training do students receive?)

## Course Features

15. (How long is training and what sequence is used? How is
    pacing achieved for individuals?  For teams?  How is
    feedback provided and when?  What feedback is provided
    during hands-on training for individuals?  For teams?

## Task/Training Info

16. (Which tasks are taught only partially?  How and when will the student learn the full task?  Which tasks are taught in full?  How will the tasks that are taught only in part be integrated with the tasks which are taught in full?  Taught in school?  OJT?)

## Course Content

17. (What lesson plans are used in classroom?  How were they developed?  Who participated?  What lesson plans exist for using training devices?  Which individual tasks are trained using a specific plan of instruction?  Which team tasks are learned by the student not through course design but as unplanned consequence of other training?  What can't be trained?)

## Performance Evaluation & Measures

18. (What performance measures are used?  Are these realistic?
    Are they appropriate?  How is individual performance
    evaluated?  Team?  What standards are used to evaluate
    performance for individuals?  Normative?  Criteria-referenced?
    What standards are used to evaluate team performance?
    What measurements/techniques are used to evaluate performance
    for individuals? for teams?  After training are the students
    ready to work on operational equipment or do they require
    further training?  How is readiness judged?)

Instructor Evaluation

19.   (How are you evaluated?  Does this evaluation consider all
      the relevant information?  All of your duties?)

Attrition

20.   (What is the approximate attrition rate from this course?
      How is attrition distributed, i.e., when does it occur?
      Why does attrition occur?  What can be done about it?)

## Training Needs

21. (What areas of the training program could be improved?  Are resources and facilities sufficient?  Is the course syllabus doing the job?  Do you feel there is sufficient emphasis on team training?  Are you training what needs to be trained? Are there any questions I should have asked, but didn't?)

## Training Program Modification

22. (When you identify a training problem, how do you go about resolving it? What kinds of issues can be resolved locally? Does the process work? Who has the responsibility for program modification? The authority?)

## Respondent Information

23. (What is your AFSC/job description? What does your job
actually require you to do? What additional duties do you
have? What priority does management give to instructional
duties? What are your job needs? Is there a specialized
vocabulary that you use? How much do you know about
instructional technology? Do you feel the need to know
more? How much time would you be able to find to learn
more about team training and instructional technology?)

INTERVIEW GUIDE FOR INSTRUCTOR

The purpose of this interview is to obtain information on existing $C^3$ system training programs with special emphasis on team training elements. This information can be used to improve team training programs.


Respondent Background

System Background and Information

Mission concept (stated, most important features--do these affect your teaching?)

Personnel (definition of team, structure)

Hardware and functions

Individual tasks (AFSC job description, primary duties, secondary duties, emergency situation)

Description of tasks (equipment used, procedures, decisions made, constraints)

Team tasks (coordination/communication between individuals)

Training Program Information--Existing Training

Student background (lead in training, appropriate skill levels)

Course environment (classroom vs. simulators/training devices vs. OJT)

Course emphasis (mission, hardware operation, communication)

Training media (use of hardware, simulators, capabilities, scenario development, constraints, other media)

Course features (sequence, pacing, feedback)

Task/Training information (when will integration take place)

Course content (lesson plans, lesson plan development)

Performance evaluation and measures (standards for individual, team readiness)

Instructor evaluation (how is instructor evaluated)

Attrition (how much, why what can be done)

Training needs (syllabus, media, emphasis on team training)

Training Program Modification

Procedures for modification

Responsibility, authority

Respondent Information

AFSC/job description vs. actual duties

Time constraints

Job needs

INTERVIEW GUIDE:  STUDENTS AND RECENT GRADUATES

Respondents _____ Date _____

Title _____

Commanding Officer _____

System _____

Interviewer(s) _____

Introduction

Purpose--Survey team training programs for operators of $C^3$
systems and identify issues for R&D.

Benefit--Improvement of training programs.

Warm-up

1. (How long have you been in the AF?)

2. (What training did you receive before starting this course?
   Before you joined the AF, where were you in school?)

<u>System Knowledge and Training</u>

<u>Mission Knowledge</u>

3. (Do you know the mission of the system you are learning to
   operate? Would you like to know more?)

4. (Do you feel you understand how this equipment which you're
   learning/have learned to operate supports the mission?
   Do you feel that it would help you to know that information?)

Team Orientation

5. (Do you feel that you are a member of a team when you are operating this equipment? Is this something you are taught or does it just happen?)

6. (What happens when you go from training devices to the real equipment? Do you feel adequately prepared? If not - why?)

7. (Do you know what the other people you work with are doing and why?)

8.  (Do you understand how your job fits in with the work the others are doing?)

Evaluation of Training

9.  (Do you feel you have a good idea of how you're coming along in your course?  Could you use more feedback?  How about as a team?)

10. (What tasks are the easiest to learn?  The most difficult?
    Which tasks are you proficient in?  On which tasks will you
    require more training?  What type of training will be
    required?  How difficult will it be to advance in skill
    level?)

11. (Would you say that the job conditions are good?  How does
    this affect your attitude about your job?)

12. (Have you been asked to evaluate the training program?  Do
    you feel that you had any means of changing the training
    program?)

13. (What proportion of your class didn't make it through training? Why?)

Graduates

14. (Do you feel you received adequate training? How difficult was your adjustment to the real equipment?)

INTERVIEW GUIDE:  STUDENTS AND RECENT GRADUATES


Purpose:  Survey team training programs for operators of $C^3$ systems and identify issues for R&D.

Benefit:  Improvement of training programs.


Respondent Background

  How long have you been in the AF?

  What training did you receive before starting this course?  Before you joined the AF, where were you in school?


Mission Knowledge

  Do you know the mission of the system you are learning to operate?  Would you like to know more?

  Do you feel you understand how this equipment which you're learning/have learned to operate supports the mission?  Do you feel that it would help you to know that information?


Team Orientation

  Do you feel that you are a member of a team when you are operating this equipment?  Is this something you are taught or does it just happen?

  What happens when you go from training devices to the real equipment?  Do you feel adequately prepared?  If not - why?

  Do you know what the other people you work with are doing and why?

  Do you understand how your job fits in with the work the others are doing?


Evaluation of Training

  Do you feel you have a good idea of how you're coming along in your course?  Could you use more feedback?  How about as a team?

  What tasks are the easiest to learn?  The most difficult?  Which tasks are you proficient in?  On which tasks will you require more training?  What type of training will be required?  How difficult will it be to advance in skill level?

  Would you say that the job conditions are good?  How does this affect your attitude about your job?

  Have you been asked to evaluate the training program?  Do you feel that you had any means of changing the training program?

  What proportion of your class didn't make it through training?  Why?


Graduates

  Do you feel you received adequate training?  How difficult was your adjustment to the real equipment?


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INTERVIEW GUIDE:   OPERATIONAL UNIT
                   SUPERVISORS OR COMMANDERS

Respondent _____ Date _____

Title _____

Organization _____ Phone _____

Interviewer(s) _ _____


Introduction

Purpose--Survey team training programs for operators of $C^3$
systems and identify issues for R&D.  Follow-up with opera-
tional units to determine preparadness of recent program
graduates.

Benefit--Improvement of team training programs.

Warm-up

1.  (How long have you been in your present position?)

2.  (How long have you been associated with this $C^3$ system?)

Recent Graduates

3.  (In your opinion are the new personnel you are receiving
    adequately trained for their job?  In what areas are they
    well prepared?  Less well prepared?  How much on the job
    training is necessary to bring new personnel up to speed?)

4.  (How much refresher training is carried out here?  What
    skills/tasks are emphasized?)

5. (What are the attitudes of the operators towards their jobs?  How is morale?  Do you anticipate any problems retaining your good people?  How could retention be improved?  What are the promotion opportunities?)

## Training Improvement

6.  (How could the current training program be improved?  Are
    there any features of your OJT program that should be
    incorporated in initial or school training?  Do you have
    any input into evaluation or modification of the training
    program?)

7. (Are there any questions I should have asked?)

INTERVIEW GUIDE:  OPERATIONAL UNIT SUPERVISORS OR COMMANDERS

Purpose:  Survey team training programs for operators of $C^3$ systems and identify issues for R&D.  Follow-up with operational units to determine preparadness of recent program graduates.

Benefit:  Improvement of team training pro-rams.

Respondent Background

   How long have you been in your present position?

   How long have you been associated with the $C^3$ system?

Recent Graduates

   In your opinion, are the new personnel you are receiving adequately trained
      for their job?  In what areas are they well prepared?  How much on the job
      training is necessary to bring new personnel up to speed?

   How much refresher training is carried out here?  What skills/tasks are
      emphasized?

   What are the attitudes of the operators towards their jobs?  How is morale?
      Do you anticipate any problems retaining your good people?  How could
      retention be improved?  What are the promotion opportunities?

Training Improvement

   How could the current training program be improved?  Are there any features of
      your OJT program that should be incorporated in initial or school training?
      Do you have any input into evaluation or modification of the training program?

   Are there any questions I should have asked?

INTERVIEW GUIDE: SYSTEMS PROGRAM OFFICE STAFF
Acquisition Planners and System Designers

Respondent _____ Date _____

Title _____

Organization _____ Phone _____

Interviewer(s) _____

Introduction

Purpose—Survey team training programs and future $C^3$ systems to identify issues for training R&D.

Benefit—Increased readiness through anticipation of personnel and logistics needs.

Warm-up

1. (How long have you been with this program?  What is your background?  Civilian?  Military?  What other experience have you had in the development of $C^3$ systems?)

<u>System Background and Information</u>

<u>Design Process</u>:

2.  (How are system requirements/mission/facilities developed?
    What role does the user play in the design process?  Do
    personnel or training considerations impact the design of
    the system?  What impact do training requirements have on
    system design and operators?)

Deployment:

3.  (At what sites is (will be) the system deployed?  What is/
    will be its echelon of command?  Where is the system in the
    acquisition cycle?  Are any modifications currently being
    planned?)

Mission Concept:

4.  (What is the mission of this system?  What are considered
    the most important features of the system?  What is the
    system-system interface?)

Personnel:

5. (Team size - How large is the team that operates this system?
                How is the team defined?)

6. (Team composition - Who are the members of the team?
                       What is the composition of the team?
                       How many officers?  Enlisted?
                       What background?
                       Which team members report to others?)

<u>Hardware and Functions</u>:

7. (What hardware is being used/developed?  Computers?  Displays?
   Operator stations?  How does it/will it support the mission?
   Will any planned modifications affect the functions?)

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<u>Tasks</u>

<u>Individual</u>:

8. (Job – In terms of the AFSC, would you describe the job of
each of the individuals who will man the system?
How does the job support the mission or various
mission phases?)

9. (Duties - What are the planned primary duties?  What are
            the planned secondary duties?  How do the duties
            vary as a function of mission phase?  What is
            expected of individuals in an emergency, e.g.,
            in the event of the loss  of a team member?)

10. (Tasks - Discuss the tasks that enable performance of each
         of the duties described above.  What equipment does
         each individual interface with?  What is the nature
         of the tasks - procedures followed?  Decisions made?
         Data/information gathered, processed?  Responses/
         output generated?  What are constraints on task
         speed?  Accuracy?  Based on your experience, are
         there any unique task demands?  Have the tasks/
         duties assigned to individuals been based on lessons
         learned from your previous efforts?  How do task
         characteristics effect system design?)

Team:

11. (What are the coordination requirements among individuals
    in the performance of their jobs?  What specific duties
    require coordination/communication among team members?
    What specific tasks require one individual to provide data/
    information to another?  To receive data/information from
    another?  What are the constraints placed on inter-individual
    task perforamnce - Accuracy?  Anticipation?  Timing? )

12. (How tolerant will the system be of human error?)

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Respondent Information

13. (What is your AFSC/job description?)

14. (What does your job require you to do?)

15. (What are your job needs?)

16. (Including your current position, how many years of experience do you have in systems design or acquisition?)

17. (What specialized vocabularies have you had to learn and use?)

18. (How much do you know about instructional technology?)

19. (How much time do you feel you could spare to learn more about the interaction between hardware and training? What format would be most useful? Course? Reference material?)

20. (What are the critical decision points in the development of a system?)

21. (Who makes design decisions?  Personnel decisions?  Training?
    Other decisions?  What is the sign off process for approval
    of design?  Personnel?  Is the decision making process
    flexible or rigid?  Is the organization able to respond
    rapidly to outside requests?  Is the organization adaptable when
    confronted    with new situations?  What incentives are there
    for consideration of training issues?  Personnel issues?  What
    constrains  consideration of these issues in system design
    and acquisition?  How might team training requirements
    influence system design?  Are there any questions I should
    have asked but didn't?)

Validity Assessment/Interviewer's Comments

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OBSERVATION GUIDE

System Representative _____ Date _____

Title _____

Organization _____ Phone _____

Honeywell Observers _____

System Designation _____

Equipment/Interface Characteristics

Characterization of training device (e.g., simulator,
actual equipment, other)

1. Configuration of training device

   a. Operator stations

   b. Instructor* stations

   c. Processing system (e.g., CPU, software, peripheral devices)

_____
*Instructor - instructor, referee, or controller

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2. Operator station characteristics

   a. Number and modularity of operator stations

   b. Types of information displayed to operator

   c. Types of operator displays

   d. Types of inputs operator can make

   e. Types of operator input devices

   f. Mechanisms for assessing operator performance

   g. Feedback mechanisms--manual (e.g., verbal), automatic

   h. Similarity of training equipment to operational
      equipment

   i  Similarity of training functions to functions on
      operational equipment in operational setting.  Applies
      to trainer, simulator, or actual equipment as used for
      training.

   j. Utilization of interactive CAI methodologies

   k. Error recovery procedures

3. Instructor station characteristics

   a. Number and modularity of instructor stations

   b. Types of information displayed to instructor

   c. Types of instructor displays

   d. Types of inputs instructor can make

   e. Types of instructor input devices

   f. Methods by which the instructor assesses individual
      and team performance

   g. Methods by which the instructor provides evaluative
      or diagnostic feedback to individuals and teams

   h. Error recovery mechanisms/procedures

   i. Methods for controlling sequence of events in scenario

   j. Methods for recording, retrieving, displaying measures
      of individual and team performance

4. Processing system characteristics

   a. CPU characteristics and functions

   b. Peripheral devices (in addition to operator and instructor stations) and functions

   c. Software configuration and functions (e.g., structured of modular program architecture, language)

Training Program/Exercise Characteristics

5. Number of participants

6. Number of instructors

7. Duration/Schedule

8. Training objectives

9. Performance measures (individual and group)

10. Type of training program (e.g., formal or informal on the job training, simulation, part-task or whole-task exercise)

11. Types of scenarios developed for the training program

Operator Tasks/Constraints

12. Number of operators required to perform the system mission.
    Minimum #. Maximum #.

13. Informal task list for each operator station*
    Note primary operations.

    a. Established tasks

    b. Emergent tasks

14. Performance measures for each task

15. Performance criteria for each task

16. Emphasis placed on training frequent or critical tasks

17. Operator qualifications

---

*When large-scale exercises (e.g., Blue Flag, Red Flag) are
observed, a representative sample of $C^3$ operator stations
will be observed.

Team Tasks/Constraints

18. Informal team task list for each operator station

    a. Established tasks

    b. Emergent tasks

19. Team composition for each team task

20. Performance measures for each team task

21. Performance criteria for each team task

22. Emphasis placed on training frequent or critical tasks

## Intra-Team Communications

23. Types of communication

24. Communication channels (voice, digital, visual)

25. Information flow networks (Are there different networks (teams) for different situations?)

Instructor Activities

26. How does the instructor monitor individual and team performance?

27. How does the instructor provide individual and team feedback?

28. How does the instructor control the sequence of events?

29. How does the instructor modify the level of difficulty of the exercise?

30. How does the instructor control the training hardware and software systems?

## Training Program Evaluation

31. How well does the configuration of operator stations in the training device conform to the stations in the operational system?

32. Is the degree of fidelity of the operator stations (both hardware and functions) appropriate for the training objectives?

33. Are individual and team performance measures related to training objectives?

34. Can performance assessent be aided through automation?

35. Do operators receive immediate feedback?

36. Do instructor stations display appropriate information and accept appropriate input?

37. How can the processing system be improved to enhance the instructor's capabilities to monitor students, provide feedback, and control the hardware/software system?

38. How well does the training device and program/exercise meet training objectives?

39. Compare actual and nominal individual task lists.

40. Compare actual and nominal team task lists.

41. Compare actual and nominal team structure and information flcw networks.

42. Does the processing system have the capacity to support current training functions?

43. Is the processing system expandable to meet future training requirements?

44. Can the generation of courseware for the system be facilitated through the use of a standardized CAI software package?

## Validity Assessment

APPENDIX C


REPRESENTATIVE COURSE TRAINING STANDARDS (CTS)

# APPENDIX C

## REPRESENTATIVE COURSE TRAINING STANDARDS (CTS)

The CTS for the ADWC/IWS APQ Air Weapons Controller Course and the JSS Weapons Controller Course are reproduced here. The proficiency level to be achieved for each knowledge/skill is coded in the righthand column of the table.

## TABLE C-1. CTS: ADWC/IWS APQ AIR WEAPONS CONTROLLER COURSE (CTS ADWC 1741B00)

| | Scale Value |
|---|---|
| **Proficiency Level Definitions** | |
| The instructor demonstrates the task at the terminal desired proficiency level. | D |
| The student must be prompted on how to perform the task and when to perform the task. | 1 |
| The student is capable of performing the task, but may need prompting on when to perform the task. | 2 |
| The student is capable of performing the task under briefed/standard situations. Needs prompting in nonstandard situations. | 3 |
| The student is capable of performing the task quickly and accurately in nonstandard situations. | 4 |
| **Academic Knowledge Level Definitions** | |
| Can identify basic facts and terms about the subject. | A |
| Can explain the relationship of basic facts and state general principles about the subject. | B |
| Can analyze facts and principles and draw conclusions about the subject. | C |
| Can evaluate conditions and make proper decisions about the subject. | D |

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## TABLE C-1. CTS: ADWC/IWS APQ AIR WEAPONS CONTROLLER COURSE (CTS ADWC 1741B00) (continued)

|  | Academic Knowledge Level |
|---|---|
| **Introduction to Automated Control** |  |
| 1. Automated Operational Units | A |
| 2. Flow of Information |  |
|    a. Computer component functions | A |
|    b. Coordination of computer information | B |
| 3. Outputs |  |
|    a. Tracking program | B |
|    b. Weapons program | B |
|    c. Voice-data link | B |
| **Console Familiarization** |  |
| 1. Displays |  |
|    a. Data | A |
|    b. Unique track | A |
|    c. Non-track symbology | A |
|    d. Fighter mission SID | B |
|    e. Offsets | B |
|    f. Fighter mission TD | B |
| 2. Switch Actions |  |
|    a. Request information | B |
|    b. Induce change | B |
|    c. Initiate an action sequence | B |
| 3. WC/WCT Request |  |
|    a. Request information | B |
|    b. Induce change | B |
|    c. Initiate an action sequence | B |

## TABLE C-1. CTS: ADWC/IWS APQ AIR WEAPONS CONTROLLER COURSE (CTS ADWC 1741B00) (continued)

|  | Academic Knowledge Level |
|---|---|
| **Voice Control** | |
| 1. When to Use Voice Control | B |
| 2. Airspace Briefing | C |
| 3. Voice Transmissions | B |
| 4. Brevity Code | |
|    a. Equipment | B |
|    b. Aircraft mission situation | B |
|    c. Intercept status | B |
|    d. Request for information | B |
| 5. Computer Malfunctions | B |
| 6. Data Link/Radio Telephone Procedures | B |
| **Intercept Safety Procedures (JM 55-200)** | |
| 1. Responsibilities for In-Flight Separation | B |
| 2. Minimum Separation | C |
| 3. General Procedures | B |
| 4. Weapons Controller Procedures | C |
| 5. Fighter Procedures | C |
| 6. Target Procedures | C |
| 7. Special Procedures | C |
| 8. FAA/RAPCON Separation Minimums | B |
| **Air Traffic Control Procedures** | |
| 1. Airspace Classifications | B |
| 2. ATC-ADCF Radar Handoffs | C |
| 3. Mission Aircraft Check-In | C |
| 4. Maintaining Assigned Airspace | D |
| 5. Conflicting Traffic | D |
| 6. ADCF-ATC Recoveries | C |
| **Emergency Procedures** | |
| 1. Recognition of an Emergency | B |
| 2. Minimum Immediate Required Actions | B |
| 3. Additional Information/Actions | B |

TABLE C-1. CTS: ADWC/IWS APQ AIR WEAPONS CONTROLLER
COURSE (CTS ADWC 1741B00) (continued)

Academic
Knowledge
Level

Fighter Guidance

1. Mission Description
    a. Definition fighter missions     A
    b. Definition computer phases     A
    c. Fighter mission computer phases     A
    d. Fighter mission attack options     B
2. Interception Mission: Approach Phase
    a. Geometry     A
    b. Profile selection     B
    c. Approach altitude selection logic     B
    d. Profile monitoring     A
    e. Approach parameter overrides     B
3. Interception Mission: Attack Phase
    a. Entry/Exit     A
    b. Cutoff attack segment
        1) Guidance     B
        2) Pursuit phase     B
        3) Monitoring     B
    c. Pursuit attack option     B
    d. Stern attack option
        1) Guidance     B
        2) Monitoring     B
4. Automatic Attack Option Selection
    a. Causes     B
    b. Target altitude     B
    c. Attack option monitoring     B
    d. Medium altitude, high-speed logic     B
    e. Transonic speed zone logic     B
5. Attack Segment Overrides
    a. When the overrides may be inserted     B
    b. When the overrides become effective     B
    c. Effects     B
    d. Cancellation     B

## TABLE C-1. CTS: ADWC/IWS APQ AIR WEAPONS CONTROLLER COURSE (CTS ADWC 1741B00) (continued)

|  | Academic Knowledge Level |
|---|---|
| **Data Link (DL)/Fire Control System (FCS)** | |
| 1. Data Link Equipment | |
|    a. Ground | A |
|    b. Airborne | A |
| 2. Types of Data Link Information | |
|    a. Test | A |
|    b. Close control (CC) | B |
|    c. Modified close control (MCC) | A |
| 3. Airborne Data Link Checks | A |
| 4. Fire Control System | |
| 5. Controller Action Implications | A |
| **Electronic Warfare (EW)** | |
| 1. Radar Theory | B. |
| 2. Passive Electronic Warfare (ELINT) | A |
| 3. Active Electronic Warfare | |
|    a. Reradiation countermeasures | B |
|    b. Radiation countermeasures | B |
| 4. Tactical Countermeasures | |
|    a. Equipment | B |
|    b. Execution (battle techniques) | B |
| 5. Counter-Countermeasures | |
|    a. Weapons Controller | B |
|    b. Aircrew | A |
|    c. MIJI Reporting | A |
| 6. Passive Tracking | |
|    a. Activation of passive tracking | B |
|    b. Initiation | B |
|    c. Implications | B |
| **Sage Orientation** | |
| 1. Location of Air Divisions | A |
| 2. Inter-Unit Relationship | A |
| 3. Functional Areas within the ADCC | A |

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TABLE C-1. CTS: ADWC/IWS APQ AIR WEAPONS CONTROLLER
COURSE (CTS ADWC 1741B00) (continued)

|  | Academic Knowledge Level |
|---|---|
| 4. Weapons Equipment | |
|    a. Console | A |
|    b. Communications | A |
| 5. Use of Weapons Console | |
|    a. Setup | A |
|    b. Switch actions | A |
|    c. Activations | A |
| 6. Displays | |
|    a. Weapons SID | A |
|    b. Weapons DID | A |

Special Missions

|  | |
|---|---|
| 1. Identification Intercepts | B |
| 2. Coordinated Attacks | B |

|  | Proficiency Level |
|---|---|

Proficiency Training

|  | Proficiency Level |
|---|---|
| 1. Planning | |
|    a. Mission schedule--Live | 3 |
|    b. Mission schedule--Simulation | 3 |
|    c. Aircrew Briefing--Live | 3 |
|    d. Airspace | 3 |
|    e. System limitations | 2 |
|    f. Weather | 3 |
|    g. Handoff | 3 |
|    h. Aircraft symbology | 3 |
|    i. Tactics | 3 |
|    j. Overrides | 3 |
|    k. Initial pattern | 3 |
|    l. Briefed pattern | 3 |
|    m. Track monitor | 3 |
|    n. Recovery | 3 |
|    o. Emergencies | 3 |
|    p. Malfunctions | 3 |

TABLE C-1. CTS: ADWC/IWS APQ AIR WEAPONS CONTROLLER
COURSE (CTS ADWC 1741B00) (concluded)

|  |  | Proficiency Level |
|---|---|---|
| 2. | Pre-Intercept | |
| | a. Console setup | 3 |
| | b. WCT/TM briefing | 3 |
| | c. Initial symbology/data association | 3 |
| | d. Handoff | 3 |
| 3. | Interception | |
| | a. Initial set-up | 2 |
| | b. Cutoff--Heading | 2 |
| | c. Cutoff--Altitude | 2 |
| | d. Cutoff--Speed | 2 |
| | e. Reattack | 2 |
| | f. Stern--Heading | 2 |
| | g. Stern--Altitude | 2 |
| | h. Stern--Speed | 2 |
| | i. CAP--Heading | 3 |
| | j. CAP--Altitude | 3 |
| | k. CAP--Speed | 3 |
| | L. Overrides | 3 |
| | m. Symbology/Data Association--2 nmi | 3 |
| | n. Symbology/Data Association--5 nmi | 3 |
| | o. Safety--Traffic | 3 |
| | p. Safety--Radio transmissions (R/T) | 3 |
| | q. Safety--Spillout coordination | 3 |
| 4. | Post-Intercept | |
| | a. Pre-Recovery--Planning | 3 |
| | b. Pre-Recovery--Notification | 3 |
| | c. RTB--Heading | 3 |
| | d. RTB--Altitude | 3 |
| | e. RTB--Speed | 3 |
| | f. ATC Recovery--Call | 3 |
| | g. RTB--Weather/fuel | 3 |
| | h. ATC clearance | 3 |
| | i. Mission completion procedures | 3 |
| 5. | Quick Action Procedures | |
| | a. Emergency--Immediate | 3 |
| | b. Emergency--Time permit | 2 |
| | c. Malfunction--Ground equipment | 3 |

## TABLE C-2.  CTS JSS WEAPONS CONTROLLER COURSE
## QUALITATIVE REQUIREMENTS

**QUALITATIVE REQUIREMENTS**

CTS E10SC1744 006

| | SCALE VALUE | DEFINITION: The individual |
|---|---|---|
| **PROFICIENCY CODE KEY** | | |
| **TASK PERFORMANCE LEVELS** | 1 | Can do simple parts of the task. Needs to be told or shown how to do most of the task. (EXTREMELY LIMITED) |
| | 2 | Can do most parts of the task. Needs help only on hardest parts. May not meet local demands for speed or accuracy. (PARTIALLY PROFICIENT) |
| | 3 | Can do all parts of the task. Needs only a spot check of completed work. Meets minimum local demands for speed and accuracy. (COMPETENT) |
| | 4 | Can do the complete task quickly and accurately. Can tell or show others how to do the task. (HIGHLY PROFICIENT) |
| ***TASK KNOWLEDGE LEVELS** | a | Can name parts, tools, and simple facts about the task. (NOMENCLATURE) |
| | b | Can determine step by step procedures for doing the task. (PROCEDURES) |
| | c | Can explain why and when the task must be done and why each step is needed. (OPERATING PRINCIPLES) |
| | d | Can predict, identify, and resolve problems about the task. (ADVANCED THEORY) |
| ****SUBJECT KNOWLEDGE LEVELS** | A | Can identify basic facts and terms about the subject. (FACTS) |
| | B | Can explain relationship of basic facts and state general principles about the subject. (PRINCIPLES) |
| | C | Can analyze facts and principles and draw conclusions about the subject. (ANALYSIS) |
| | D | Can evaluate conditions and make proper decisions about the subject. (EVALUATION) |

**– EXPLANATIONS –**

\*  A task knowledge scale value may be used alone or with a task performance scale value to define a level of knowledge for a specific task. (Examples: b and 1b)

\*\*  A subject knowledge scale value is used alone to define a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks.

–  This mark is used alone instead of a scale value to show that no proficiency training is provided in the course, or that no proficiency is required at this skill level.

X  This mark is used alone in course columns to show that training is not given due to limitations in resources.

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TABLE C-2.  CTS JSS WEAPONS CONTROLLER COURSE
QUALITATIVE REQUIREMENTS (concluded)


Tasks, Knowledge, and Proficiency Level

1. Introduction/Description
   a. System overview                                    B
   b. ROCC functional areas
      1) Battle staff                                    C
      2) Weapons                                         C
      3) Surveillance                                    C
      4) Identification                                  C
      5) Manual inputs                                   C
      6) Computer operations                             C
   c. Hardware
      1) Display console                                 B
      2) Remote access terminal                          B
      3) Data processing equipment                       B
      4) Status/plotting boards                          B
      5) Equipment configuration                         B
      6) DP string utilization with complex              B
2. Applications Set
   a. Use and interaction                                C
   b. Terminology                                        C
   c. Introduction of operational programs               C
3. Consoles
   a. Physical characteristics
      1) Display                                         C
      2) Tabular                                         C
      3) Situation                                       C
      4) Attention                                       C
   b. Interaction of displays                            C
   c. Operate display console                            3c
   d. Analyze displays                                   3c
   e. Switch Actions                                     3c
4. Crew Training                                         2c

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